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## Forthcoming Events.

APRIL 10.

*Institute of Metals (London Local Section)*:—Annual general meeting in London. "Metals in the Gaseous State," Paper by C. H. M. Jenkins.

APRIL 11.

*The Mining Institute of Scotland*:—Annual meeting at Glasgow.

APRIL 14.

*Manchester Geological and Mining Society*:—Ordinary meeting at Manchester.

APRIL 17.

*Diesel Engine Users' Association*:—Ordinary meeting in London. "Recent Oil Engine Developments," Paper by J. T. Chaloner.

*Institute of British Foundrymen (Sheffield and District Branch)*:—Ordinary meeting at Fargate. "Jolt Ramming Machines in the Foundry," Paper by G. Edginton, and "The Production of Good Sound Castings in Cast Iron," Paper by C. Webster.

APRIL 20.

*Institute of Transport*:—Ordinary meeting in London. "Shipping from the Provinces," Paper by F. T. Walker.

**THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.**

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***Foundry Trades Equipment & Supplies Association.***
**Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.**

## The Present Position of Semi-Steel.

A considerable portion of this issue is devoted to the subject of semi-steel. The most interesting aspect of this subject is the mechanism of the melting of the steel portion of a cupola charge. Two writers have detailed experiments carried out with the object of throwing light upon it. Fortunately, they are complementary to each other. Mr. Field has shown by means of an all-steel charge that for all practical purposes the major portion of the carbon "pick up" is whilst the metal is lying in the hearth of the furnace waiting to be tapped. Dr. Stead found when melting steel alone in the cupola it picked up about 3 per cent. Mr. Field says: "Steel can be melted in the cupola, and during its descent from the melting zone to hearth there is absorbed 3 per cent. of carbon." "A Metallurgical Correspondent" states: "Under ordinary conditions of cupola melting the steel scrap will absorb practically about 3 per cent. carbon."

Both authors agree that in the actual melting zone there is sufficient carbon absorption to reduce the melting point to within the limits of a cupola, the temperature of 1,500 deg. C. being cited by Mr. Field. We suggest that there is very little difference, if any, between the temperature of a cupola melting zone and a crucible steel melting furnace, which can, with difficulty, melt pure Swedish bar iron. It is interesting to note that Mr. Field found little or no carbon absorption in pieces of recovered half-melted steel. We suggest that this is purely a question of non-intimacy of the steel and coke, time and temperature. The carburising efficiency of cupola stack gas we would not deem to be high, whilst carbon-contact carbonising is bound to be poor, owing to the irregular shape of the coke. Thus it can be reasonably assumed that Mr. Field's conclusions are normal conditions, and that real carburisation is carried out in the melting zone.

It has been said that the steel in a semi-steel charge melts before the pig-iron, but it should be borne in mind that some pig-irons have a very highly refractory sand coating, so much so that the centre will sometimes melt away, leaving a skeleton outline of its former shell.

Commercially, semi-steel presents a cheap method of making a good class iron—both authors have well emphasised that factor. Chemically, however, increased mechanical properties can be ascribed to lower silicon and phosphorus, and their relationship to the graphite, which is, after all, the controlling factor. Whilst high total carbons are met with when making semi-steel, it can be taken for granted that year in year out a lower average is obtained than when working with pig and iron scrap mixtures, even though an effort is made to keep to the silicon content of the charge low. It is thought in some quarters that the next step in cupola practice will be the introduction of a slight Bessemerising, and, in fact, some of the later modifications claim this. It should be borne in mind, however, that for the general run of foundry work cast iron, as it is to-day, is good enough, and it is only high-class cylinder work and a few other jobs which really warrant a better material. All foundrymen would welcome better iron, providing it does not increase the cost. This is one of the factors which has contributed to the large, if irregular, success of semi-steel.

## Non-Ferrous Metals Research Association.

The fifth annual luncheon of this Association was held last Friday at the Savoy Hotel. It was presided over by Mr. Thomas Bolton, who drew attention to the new arrangement between the Association and the Department of Scientific and Industrial Research, by which they had to become self-supporting. In place of the grant on a pound per pound basis, which had been in operation during the first five years of the Association's life, the Government had made an offer of a total sum of £24,000 in the next five years, contingent on the Association raising in subscriptions from the industry a total contribution in the same period of £56,000. The Government grant would start with a maximum of £8,000 in the first year, and diminish each year by 20 per cent. of this sum. Subscriptions would have to increase year by year in like proportion to make good the deficiency. At the close of the period the Association would be self-supporting, and that meant doubling the subscriptions in the next five years. A separate arrangement had been made regarding certain sections of the non-ferrous industry, such as brass-founding, galvanising, and lead, which had not yet had a fair opportunity of participation. A supplementary grant on the pound per pound basis would be made by the Government in respect of contributions from these sections.

Sir Robert Horne, M.P., said in the past too little account had been taken of science by British manufacturers, but with the great bulk of our industries confronted with immense difficulties they realised that the only way to compete in the markets of the world was to get down costs of production. Scientific investigation sought to get better results for less money, and therefore it was of vital importance to-day. He regretted to notice the poor representation of his fellow-countrymen from north of the Tweed in the list of members of the Society. "Brazen Birmingham" was more than adequately represented, but "Genial Glasgow" had only one solitary member.

Engineer Vice-Admiral Sir Robert Dixon spoke of the great value to the fighting services, and especially to the Navy, of the work of the Association. In the seven ships composing the Special Reserve Squadron which recently voyaged round the world there were 163,000 condenser tubes. The ships were away ten months, during which time steam was never altogether let down, and they covered about 40,000 miles. Of those 163,000 condenser tubes only five gave out—a result reflecting great credit on the manufacturers and on the Admiralty specification and system of inspection.

Mr. Douglas Vickers, speaking as a steel user of long experience, appealed to engineers and users to give all powers to the Association by joining it and bringing in their friends.

Mr. H. T. Tizard, of the Department of Scientific and Industrial Research, said the Association was entering upon the second and more critical period of its work. Only the highest appreciation of its past services had induced the Government to make the new offer.

The annual meeting, which preceded the luncheon, was held in private.

Amongst those present were Rt. Hon. Sir Alfred Mond, Bt., M.P., Sir Henry Fowler, K.B.E., Sir John Dewrance, K.B.E. (President of the B.C.I.R.A.), Sir Richard Redmayne, K.C.B. (Chairman, Imperial Mineral Resources Bureau), Sir J. E. Thornycroft, K.B.E., Sir James Kemnal, Sir Thos. K. Rose, D.Sc., Mr. W. H. Patchell (President, Institute of Mechanical Engineers), Prof. Thos. Turner (President, Institute of Metals), Mr. Humphrey M. Morgans (President, Institute of Mining and Metallurgy), Col. R. A. Johnson, C.B.E. (the Royal Mint), Mr. H. N. Gresley (L. & N.E. Railway), Dr. W. Rosenhain, F.R.S. (National Physical Laboratory), Mr. F. Tomlinson (Vice-Chairman, Non-Ferrous Metals Research Association), Mr. V. C. Faulkner (Vice-President, Institute of British Foundrymen), Mr. S. L. Archbutt (N.P.L.), Dr. Guy Bengough, Mr. C. C. Bissett (Fry's Metal Foundry), Dr. H. W. Brownsdon, Mr. E. R. Canning, Mr. P. Dunsheath, Mr. J. Fry, Mr. R. Genders (Woolwich Research), Mr. R. C. Griffith (Woolwich Research), Dr. D. Hanson (N.P.L.), Mr. F. W. Harbord, Mr. E. Carey Hill, Mr. J. G. Pearce (Director, B.C.I.R.A.), Mr. H. B. Weeks (Vickers, Limited), Mr. G. Shaw Scott (Secretary, Institute of Metals), and Dr. Hutton (Director and Secretary of the Non-Ferrous Metals Research Association).

## The Glasgow Convention.

The annual Convention of the Institute of British Foundrymen, which is to be held in Glasgow on June 10, 11 and 12, 1925, will be presided over by Mr. John Cameron, of Messrs. Cameron & Roberton, Limited, of Kirkintilloch, who is at present senior Vice-President.

A distinguished Reception Committee, with the Right Hon. Lord Weir of Eastwood, P.C., D.L., LL.D., as President, and the Rt. Hon. Lord Invernairn of Strathnairn, Sir Archd. McInnes Shaw, C.B., LL.D., Sir Frederick L. Macleod, K.B.E., Ex-Bailie John A. Balderston, Captain H. J. Kennard, R.N., Mr. John King, Mr. Wm. Turner Maclellan, C.B.E., Mr. George Pate, O.B.E., J.P., Mr. A. W. Steven, Mr. Geo. Albert Ure, J.P., and the Past-Presidents, Scottish Branch, as Vice-Presidents, has been formed for the reception and entertainment of the guests. The general arrangements are in the hands of a local Executive Committee, consisting of Mr. James Affleck, B.Sc., Chairman, Mr. A. Campion, F.I.C., and Mr. John Bell, Hon. Secretary and Treasurer.

It is estimated that at least £500 will be required to defray the expenses of the Convention, and the Executive Committee confidently appeal to the foundry and allied trades in Scotland for their financial assistance in this matter to enable them on this occasion to extend the usual hospitality to the many visitors from various parts of the country.

Subscriptions toward the expenses fund will be welcomed by the Executive Committee, and acknowledged by Mr. John Bell, 60, St. Enoch Square, who has been appointed Hon. Secretary to the Convention, and through the Press.

## An International Exchange Paper.

Mr. G. H. Clamer, the past-President of the American Foundrymen's Association, who headed the delegation which visited Europe in 1923, is to present a Paper to Association Technique de Fonderie on behalf of the A.F.A. next September in Brussels. As he is connected with the Ajax Metal Company, the Paper will deal with a non-ferrous subject.

A party of members of the Metallurgical Society of the Birmingham University, left that city on March 26 for a two-weeks' tour of the industrial establishments in Belgium and the Ruhr area of Germany.

**National Physical Laboratory Report for 1924.**—The Executive Committee are again able to report a year of good work and progress. The steady growth of the work recorded for 1923 has been maintained during 1924. The demands made by the Research Boards and Committees of the Department of Scientific and Industrial Research, for research needed to meet the requirements of other Government Departments, continue to increase. Work for the Service Departments has been maintained on approximately the same scale as in previous years, while there has been an increase in the tests and investigations undertaken for firms. The Committee feel that it is very desirable there should be as little interference as possible with the fundamental research and standardisation work of the Laboratory, notwithstanding the pressure of external requirements, and they have found it necessary to ask for an increase in the "Establishment" of the Laboratory, and again to press the need of additional accommodation. Their representations have received sympathetic consideration, and it is hoped that a commencement will be made during 1925 with the erection of a portion of the proposed new Physics Building.

# New Iron Foundry at the Darnall Works of Messrs. Davy Brothers, Limited.

The Darnall Works of Messrs. Davy Bros. were formally opened on June 20, 1921, at which time the light and medium machine shops had just been put into commission. An illustrated description of these shops appeared in a contemporary,* it being pointed out that the shops dealt with constituted one unit of a complete and extensive engineering works, including offices, pattern shop, stores, iron foundry, heavy machine shops, boiler shops, etc. In the article referred to there was given a plan of the general layout; upwards of 60 acres of land having been acquired, and of this rather more than 25 acres had been levelled.

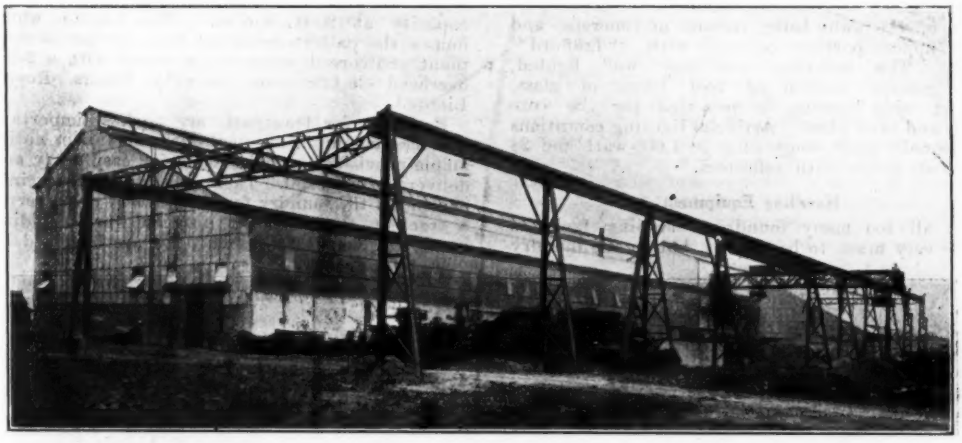

Fig. 1.—View of Foundry from Stock Yard.

As one would expect, the foundry is laid down on the most modern lines, having particular regard to the varied class of work which has to be undertaken there is obviously nothing in the nature of repetition work with the Davy Bros'. specialities. Whilst no efforts have been spared to make the foundry a highly-efficient castings factory, very

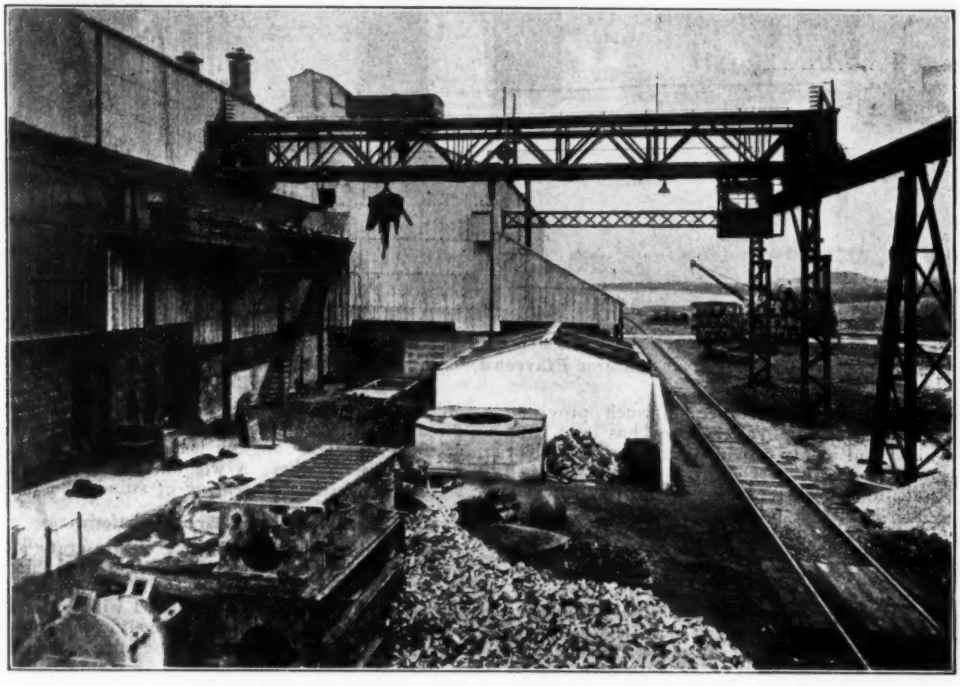

Fig. 2.—Stock Yard, showing Storage Hoppers and Scrap-breaking Pit.

The site is a very convenient one, being within three miles of the centre of Sheffield, and directly connected up with the London and North Eastern Railway, sidings from which completely encircle the works site, and tracks are also laid direct into the machine shops. The building and equipment of the iron foundry, which was recently inspected by our representative, is another step towards the completion of the general scheme. The iron foundry lies parallel with the machine shops, space being provided between it and the foundry for the erection of the smith's shop which will be separated from the foundry by the service road and the foundry stock yard.

full consideration has also been given to the comfort of the men employed; one sees many evidences of such consideration when going over the plant; matters, simple perhaps in themselves, but which in the aggregate conduce materially to better working conditions and incidentally to better work. Thus the whole of the work of the men on the charging platform is performed under cover, the ventilators in the foundry roof, instead of

* "Iron and Coal Trades Review," June 24, 1921.

being of the usual fixed louvre type are of the venetian type, operated from floor level; lavatories and latrines are also within the foundry buildings, so that after "Clocking On" there is no need for the men to leave the foundry.

The foundry is covered by a main bay 390 ft. × 60 ft. span and clear height of 30 ft. to the crane runway; the light bay is 120 ft. × 60 ft. × 25 ft. high to the crane runway, and a lean-to 210 ft. × 30 ft. × 22 ft. 6 in. to the crane runway. The buildings are steel framed, the constructional work being supplied by Messrs. Redpath, Brown & Company, Limited, the lower portion of the walls being formed of concrete, and the upper portion covered with "Trafford" tiles. The buildings are very well lighted, the greater portion of roof being of glass, whilst side lighting is provided for the core shop and sand plant. Artificial lighting conditions are equally good, comprising 30 1,000-watt and 28 500-watt lamps with reflectors.

### Handling Equipment.

In all too many foundries handling facilities leave very much to be desired, but in the foundry under notice the importance of such provision as a factor in foundry efficiency has been fully recognised and amply provided for. Thus the floor of the main bay is served by a 40-ton Heywood and a 25-ton Royce crane—each of these cranes being fitted with a 5-ton auxiliary hoist—and a 15-ton crane by J. Adamson. Provision has also been made for the installation, at a later date, of a 60-ton crane. Obviously crane capacity places a limit on the weight of individual castings produced; at the moment castings up to 40 tons are made, but it will be seen this does not represent the possibilities of the plant. In addition to the overhead-crane equipment, jib cranes capable of lifting 3 tons at a radius of 20 ft. are attached to stauncheons at convenient points throughout the shop, these cranes being motor driven in the lifting and lowering motions, racking and slewing being hand-operated. The whole of the crane gearing is totally enclosed in dust-proof casings.

The foundry floor is served by a 1-ton telpher, by Messrs. S. H. Heywood & Company, this being of the two-motor type, and its track extends along the two sides and one end of the foundry floor. Its main duty is the transportation of the sand from the sand plant to any point required in the heavy foundry, as also to feed the special storage hoppers serving the core department and light foundry. This telpher, or transporter, is fitted with a Priestman grab of the combined hand and self-dumping type, arranged for discharge when suspended, by hand-operation of a cord, or automatically, when the tension on the suspension rope relaxes as the grab comes to rest on the ground or dump. The heaped capacity of the grab is 12 cub. ft., its weight when empty, is 10 cwts. and its flush capacity 10 cub. ft.

The crane equipment of the light bay comprises a 10-ton crane of the 3-motor type by Messrs. Royce, Limited, and also four jib cranes of 1-ton capacity at 20-ft. radius. The lean-to which houses the pattern-receiving floor, sand-treatment plant and core department, is served with a 2-ton overhead electric crane, also by Messrs. Royce, Limited.

Facilities for transport are no less important than crane equipment; in the foundry under notice ample provision has been made for easy entry and delivery of material. There is a line of track into one end of the foundry for the delivery of patterns, a track in the mid-floor position for moulding boxes, the bogies for which duty are operated by an electric capstan with positive drive in either direction, whilst at the opposite end of the foundry a track at right angles leads direct into the machine shop, where a weighbridge is provided, the whole of the tracks being of standard gauge.

Fig. 3.—View on Charging Platform, showing Charging Skip on Bogie.

### Stock Yard and Charging Platform.

The stock yard is 300 ft. long with a crane span of 70 ft., the crane rails being laid at a height of 28 ft. 6 in. The crane of 20-ton capacity by Messrs. Royce, Limited, is fitted with a 5-ton auxiliary hoist. This crane, according to the duty upon which it is for the time being engaged, carries a Phœnix 1-ton lifting magnet 52 in. dia., which is controlled by a set of Phœnix patent contactor gear, or a Priestman combined hand and self-dumping grab.

Normally the iron is delivered in quarter pigs by truck along a track which is laid between the charging platform and a range of six storage hoppers. These hoppers are built of ferro-concrete, wood lined, and have each a storage capacity of 90 tons, and in them the pig-iron, discharged from the truck by electric magnet, is stored according to brand. This storage forms the reserve stock, as so far as the capacity of the charging platform bins—approximately 50 tons—are concerned, the

pig and scrap are delivered direct from the trucks by the crane and magnet. The crane, of course, also feeds the iron from the storage hoppers to the bins on the charging platform. The scrap-breaking pit is placed at the side of the bins and is shown in Fig. 2. The pit is of concrete, sleeper lined; the breaking ball is easily handled by the lifting magnet. Coke is discharged from the trucks into skips, which are lifted by the crane and deposited on a bogie on the charging platform.

The charging platform (Fig. 3) calls for special consideration, as in many respects it is unique; it is 20 ft. above ground level, 60 ft. long × 36 ft. wide, being continued over the stoves to act as a coke store. It is constructed of reinforced concrete and is covered with a span roof. The service bins are clearly to be seen on the right of Fig. 3. The open ends of these bins are arranged above a well, so as to bring them level with the top of the charging skips; these skips, during loading, are carried on a special bogie, which travels a track within the well. It is provided with a pocket to receive the skip, and in its design is embodied a Pooley 2-ton weighing machine, the dial of which is provided with four movable indicators arranged circumferentially, so that they can be set to the different weights required. It will be understood that the loading men are not called upon to do any lifting, the pig or scrap being pulled forward by a hand hook and then dropped by hand into the skip. A taring steelyard is provided for the skips, and the provision of the indicators render the loading of the weights easy and rapid. The skip bogie is operated along the track by haulage gear controlled from the bogie.

The skips are provided with drop-bottoms and can be discharged into any one of the four cupolas. The design of the skips has been modified from experience gained with the earlier form of drop-bottom, and is now entirely satisfactory. The skip is transported when loaded by means of the crane rope attached to the drop-bottom, further ropes being attached to the skip on each side; when over the cupola the central rope is lowered, and as the skip is then held by the side ropes, the bottom is opened by the weight of the charge which is deposited without any risk of sticking. The skip-charging crane is of the overhead underhung jib type of 2-tons capacity, and is provided with an extra barrel for operating the skip discharge.

### Melting Plant.

The melting plant comprises four cupolas, which, as will be understood from our description of the charging platform, are grouped. The sizes and capacities of the cupolas are as follows:—

| Diameter of shell. | Diameter of lining. | Melting capacity per hour. |
|---|---|---|
| In. | In. | Tons. |
| 72 | 54 | 10 to 12 |
| 56 | 38 | 7 |
| 46 | 32 | 3½ to 4 |
| 41 | 29 | 2 |

Supplied by Messrs. J. W. Jackman & Company, Limited, they are of the usual Whiting type and are fitted with drop-bottoms. Pits are provided beneath the cupolas, which are connected by tunnels provided with rail tracks serving wells adjacent to the storage hoppers in the stock yards. At the end of each blow the bottom of the cupola is dropped and the remainder of the charge is deposited into a skip mounted on a slag bogie; the bogie is hauled through the tunnel to the outside well by the crane operating through a snatch block. The skip is then lifted out by the yard crane and its contents dumped on the waste heap.

The 7-ton cupola is provided with a swivelling spout, so that iron can be delivered into the heavy or light foundries as required, a simple enough contrivance, but one which, when the light foundry is taking the iron, will save a considerable amount of labour in handling. The arrangement of the cupolas, of course, permits of the centralisation of the blowing plant, and the whole of the fans are installed in a ferro-concrete room entirely shut off from the foundry, to which entrance is obtained from the foundry yard.

The whole of the fans installed were supplied by Messrs. Keith Blackman. The fan for the large cupola comprises a cast-iron housing with 12-in. dia. flanged outlet, a mild-steel impeller 40 in. dia., and cast-iron bedplate extended for the reception of a motor of 40 h.p. running at 1,450 r.p.m. The fan is capable of delivering 6,000 cub. ft. per min. at an outlet pressure of from 24 to 25 in. w.g., the actual power consumption at this duty being 36 h.p. Two fans similar to the above but with 8-in. dia. outlets and 20-in. dia. impellers, driven by 20-h.p. motors at 2,900 r.p.m., and capable of delivering 2,500 cub. ft. per min. at an outlet pressure of 25 in. w.g., or alternatively 3,000 cub. ft. per min. at the same pressure, take 15.7 and 19 h.p. for the respective duties. A similar fan with a 10-in. dia. outlet and 24-in. impeller is driven by a 20-h.p. motor. In addition to these, there is a Duplex fan by Messrs. Alldays & Onions, Limited, which is driven by a 26-h.p. motor. This fan acts as a

Fig. 4.—View of Main Bay from Casting End.

standby, and is capable of blowing any of the three smaller cupolas.

### Sand Preparation.

The sand-treating plant is very complete and efficient, and is capable of dealing with 5 tons of facing sand per hour, the output, of course, being considerably greater with sand which only requires reconditioning. One man is required to feed the new and old sand on to the elevator. With this exception, the plant is automatic in operation. The sand is discharged from the trucks on the stock-yard sidings direct into two ferro-concrete hoppers which are built on to the foundry wall and open into the foundry. In addition to these hoppers, a large ferro-concrete bunker at the side of the wagon road acts as a reservoir storage for sand.

The black or used sand returned from the foundry is also delivered to the same point by means of a belt conveyor which takes its feed from a steel storage hopper into which the used sand is delivered by the transporter already referred to. The conveyor delivers on to a "Vulcan" return-feed sand-sifter by Messrs. Jackman, Limited, the riddled sand being discharged on to the floor conveniently near the new sand and coal-dust storage bins. After mixing on the floor, the sand is taken up by a chain bucket elevator and delivered into a 7-ft. dia. pan mill with rollers 42 in. dia. and 13-in. face. From this mill the sand falls into a 30-in. sand mixer of the double revolving-reel type by C. E. V. Hall, from which a belt conveys the sand into one of three storage bins, or alternately on to a cross conveyor which feeds two further bins. The cross conveyor is so placed as to be capable of delivering into a second roller mill which is used for making loam. The arrangement of the plant also provides for cutting out, by means of an adjustable shute, the first roller mill, the sand being then delivered direct into the mixer and thence into the storage bins. The sand-elevating and conveying equipment was supplied by the Paterson Hughes Engineering Company. The conveyors and riddles are driven by two 3-h.p. and one 4-h.p. motors. The roller mills and the mixer are driven through belts by a 30-h.p. motor.

A contemplated addition to the sand plant is a mechanical shake-out for boxes combined with a screen and magnetic separator, which will deliver sand under the transporter. Worksop sand is used exclusively for the moulds with sea sand for cores.

### Moulding and Core-Drying Equipment.

As the castings being generally handled at the present time are of a varied class with very little repetition work, no moulding machines have so far been installed, but a special feature on the moulding floor is a portable type of the "Beardsley-Piper" sand slinger by Messrs. Foundry Plant & Machinery, Limited, Glasgow. This machine is capable of riddling and ramming sand at the rate of 7 to 10 cub. ft. per min., and can deal with any size of mould. It is fitted with totally-enclosed motors and control apparatus, and provided with push-button control for starting and stopping. Casting pits are provided in the main bay, the area of the pits being 27 ft. × 18 ft., with depths of from 7 to 10 ft., and in the case of an 8-ft. square portion, 25 ft. deep.

The core department, which, as already stated, is housed in the lean-to, is 70 ft. × 30 ft. wide. In addition to the overhead crane which serves the whole floor of the lean-to, there is in the core shop a jib crane capable of lifting 3 tons at 20-ft. radius. This can be swung round into the main bay so as to deposit the larger cores on bogies for the drying stoves. The core benches are covered with cast-iron plates machined on the upper surface. The core shop adjoins the drying stores, so that the small core oven 8 ft. × 8 ft. × 8 ft. is heated from the system common to the main stoves. The main bay is served by two stoves each 28 ft. 8 in. × 17 ft. wide and 10 ft. 6 in. wide respectively × 10 ft. high, and one stove 28 ft. 8 in. × 12 ft. 4 in. × 12 ft. high. For the light-castings bay there are two stoves 18 ft. × 12 ft. 6 in. × 9 ft.

Fig. 5.—Main Bay from Fettling End, showing Cupolas on Left.

The whole of the stoves were built by Messrs. August's Muffle Furnaces, Limited, and a separate firebox is provided for each stove. The fireboxes are placed in a pit which is totally enclosed and below ground level so as to be more efficient and economical, seeing that this arrangement permits of better control of the products of combustion; this being more successfully achieved when the design of the firebox is such that the gases rise naturally to the point where they are required.

Air is blown into the pit with a Keith Blackman low-pressure fan, and control of this through the installation is obtained by means of primary air ports by the side of the ash pit and air regu-

lators through the furnace door over the fire. Auxiliary air also passes through chequer work in the walls of the firebox and enters the main supply flue for the stoves without having come in contact with either the fuel or the gases. This air supply tempers the products of combustion to a reasonable and safe temperature for drying, and at the same time provides an adequate supply of dry air capable of absorbing moisture and holding it until passed entirely from the installation *via* the exhaust flue; by this arrangement the stoves are slightly under pressure. The air is admitted into the main flue at the back by means of regulator dampers, and is exhausted into the depressed floor, thence through the flues to the chimney. The dry, warm atmosphere makes uniform drying a certainty, and ensures efficient work.

This depressed floor, a system recently patented by Mr. H. M. Lane, of Detroit, U.S.A., constitutes a very material improvement. The hot gases passing into the chamber collect or absorb during the early stages a large percentage of moisture; this saturated atmosphere naturally falls, by reason of its weight, to the bottom of the stove chamber.

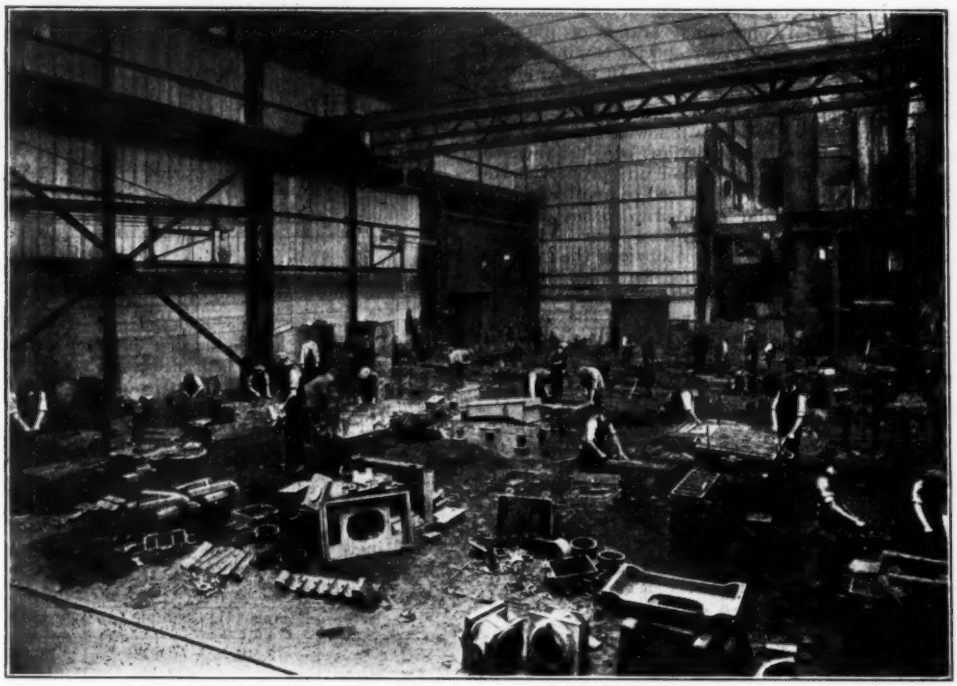

Fig. 6.—View in Light Castings Bay looking towards Cupolas.

By means of the depressed floor the heavy atmosphere immediately leaves the oven to be replaced by hot air, so that the operation of drying is not retarded and condensation on the sand structure is entirely eliminated. The doors of the stoves are of the August patent insulated type; they are suspended with wire ropes and balance weights, and as the shafts run in ball bearings one man can easily manipulate the doors. For drying moulds *in situ* there are two August portable mould dryers.

Power is taken from the mains of the Sheffield Corporation and brought to the works' sub-station at 11,000 volts, where it is stepped down to 350 volts for the A.C. motors. Current for the D.C. motors, cranes, magnet, etc., is supplied by two rotary converters of 150 and 250 kw. respectively at 220 volts. Lighting is taken at 220 volts A.C. The whole of the sub-station equipment was manufactured by Messrs. Metropolitan Vickers.

Mr. C. A. Mills, the works manager, has been responsible for the design, layout and supervision of construction, assisted by the works staff.

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A licence under the Non-Ferrous Metal Industry Act, 1918, has been granted by the Board of Trade to F. Mott & Company, Limited, Billiter Square Buildings, London, E.C.3.

## Catalogues Received.

**Roller Bearings.**—The British Timken, Limited, of Common Lane, Ward End, Birmingham, have sent us a copy of their catalogue dealing with the industrial and mechanical application of roller bearings. Illustrations are given which are of definite interest to foundrymen such as they use in conveyor systems, grinding machine spindles, patternmaking machinery, polishing heads and overhead runways. This list does not exhaust their application to foundry, as in a supplementary list their use on vertical moulding machines is indicated. We understand copies of the catalogue, which contain some forty well-illustrated art pages, are available to our readers on application.

**Furnace-Charging Machines.**—We have received from the Wellman Smith Owen Engineering Corporation, of 36, Kingsway, London, W.C.2, a copy of their latest catalogue devoted to descriptions of reheating furnace-charging machines. Conditions in industry are such that it is impossible to produce a standard design of machine, owing to variations in head room and floor, and "space-available" conditions. It has thus been thought wise to illustrate and describe a number of plants which the firm has installed. Broadly, there are two classes available—the overhead and ground type, again the conditions of installation being governed by local lay-out. The catalogue contains 20 art pages and is beautifully illustrated with coloured pictures and very clear diagrams.

**Electric Steel Furnaces.**—Messrs. British Brown Boveri, Limited, Trafalgar House, Waterloo Place, S.W.1, have sent us a catalogue outlining the features of the Brown Boveri Electric Melting Furnace. It incorporates a three-phase system, and a special feature is the detachable body, which in some cases can eliminate the use of a ladle and economises the losses due to transference. Hand regulation has been incorporated for operating the two electrodes, whilst the tilting device is hydraulically controlled. In a Table details of operation costs are given when working upon copper; 72:28 brass, 85:15 bronze, pure nickel, cupro-nickel, coin silver, anti-friction alloy, and grey cast iron. The furnace is stated to be equally suitable for steel. The whole forms an attractive proposition, and we feel that most foundrymen will be interested in securing a copy.

# Basic Principles Underlying the Manufacture of Semi-Steel.

By a Metallurgical Correspondent.

The practice of adding a proportion of steel scrap along with the usual mixture of pig and scrap iron in the cupola has gained widely in popularity during recent years, and the term "semi-steel" is now generally applied to describe all those cast-iron mixtures of which steel scrap forms a part. The use of the term semi-steel is open to much misinterpretation, and is much to be regretted on this account. This descriptive title is, however, generally accepted, and beyond suggesting the alternative title of "steel mixture," if a special term is considered necessary at all, it is not proposed to discuss this any further.

The term "semi-steel" would be more truly applicable to those mixtures of cast iron to which a proportion of molten steel has been added in the ladle. This is a practice which is often resorted to in the production of special charges for Bessemer steel making. It was also adopted many years ago, particularly on the Continent, for the production of special commercial brands of pig-iron for cylinder work and other special castings, *e.g.*, Concordia brand and Silbereisen. In this country at the time of writing special cylinder pig-irons of definite composition are being produced by certain ironmasters. The procedure followed is simply the admixture of definite proportions of blast-furnace metal and molten basic steel in proportionate quantities to produce the desired composition.

The addition of solid steel scrap to molten cast iron in the foundry ladle is also practised to a limited extent. It is at once obvious that extensive additions of steel cannot be made in this manner owing to the considerable reduction in temperature of the final metal. The use of Thermit mixtures immersed in the molten iron has been recommended as a means of preserving the temperature of the molten metal during such operations.

### Cupola Melted Semi-Steel.

The preparation of semi-steel by the addition of steel to the cupola mixture and melting in the ordinary manner is by far the most common practice. The procedure followed is quite simple and widely understood, and consists of the addition of a proportion of steel scrap along with the pig and scrap iron charged. It is found that the steel scrap readily melts under these conditions, and the resulting metal is a mixture of the melted steel together with the iron.

The melting of steel scrap at the temperatures prevailing in the cupola, temperatures which are considerably below the melting point of mild steel, is entirely due to the rapid absorption of carbon by the steel from contact with the hot coke and carbonaceous gases in the cupola. The absorption of appreciable amounts of carbon by the steel is accompanied by a considerable reduction in the melting point, and the carburised steel is rapidly converted into an alloy having a melting point well within the range of the temperature conditions prevailing in the cupola.

### Amount of Carbon Absorbed by Steel Melted in the Cupola.

It is at once obvious that the amount of carbon absorbed by the steel under cupola conditions is of considerable importance in determining the extent of any change which might take place in the total carbon contents of the finished iron. Dr. Stead, in his correspondence on the report of the Malleable Cast Iron Committee of the Iron and Steel Institute, mentions the fact of having himself, many years ago, melted steel scrap alone in the cupola for the purpose of recarburising Bessemer blown steel. Dr. Stead's product was a white iron having the approximate chemical composition as follows:—Carbon, 3.00; silicon, nil; sulphur, 0.15, and manganese, 0.40 per cent.

Probably the original carbon contents of the steel scrap thus melted would be about 0.50 per cent. maximum. The extent of the carbon absorption in this case was approximately 2.50 per cent. In passing it is of importance to note that Dr. Stead found no traces of absorption of silicon or manganese, but only a considerable increase in sulphur as would be expected.

The author has independently carried out similar experiments with exactly similar results, and the photograph of the fracture of the author's pig-iron obtained by melting steel borings alone in the cupola is shown in Fig. 1.*

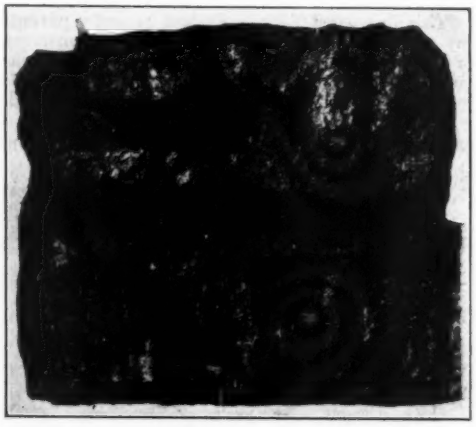

Fig. 1.—Fracture of Pig-Iron Obtained by Melting Steel Borings in the Cupola.

The following experiment is of interest in demonstrating the absorption of carbon during melting.† A charge consisting of hematite pig iron and scrap, together with 20 per cent. steel borings and plate punchings, was charged into the cupola in the following order: (1) Steel; (2) hematite; (3) scrap. Almost immediately after the blast was turned on a sample of the molten drops of metal was collected in a small clay crucible inserted through the tuyere attached to the end of of a steel rod. The analyses of two samples collected in this manner and of the final metal in the ladle are given in Table I.

Table I.—*Carbon Absorption during Melting of Steel.*

| | Sample (1). | Sample (2). | Final Metal. |
|---|---|---|---|
| CC... .. | 2.50 | 2.94 | 0.86 |
| Gr. .. | — | — | 3.07 |
| Tot. C .. | 2.50 | 2.94 | 3.93 |
| Si. .. .. | 1.21 | 1.59 | 1.63 |
| Mn. .. | — | — | 0.48 |
| S. .. .. | — | — | 0.085 |
| P. .. .. | 0.73 | 0.74 | 0.76 |

These analyses serve to show the rapidity of the carbon absorption, and the presence of silicon and phosphorus in the first sample amply illustrates the rapidity with which the whole charge melts. These experiments are also of interest in confirming the opinion generally held that the melting of the steel scrap in the cupola is partly brought about by its solution in the higher carbon portions of the mixture flowing over the steel during melting.

It is evident from these figures that under ordinary conditions of cupola melting the steel scrap will absorp practically about 3 per cent. carbon. The extent of the carbon absorption will be principally governed by the following conditions: (1) The temperature attained in the cupola; (2) the length of time of contact of the steel with the carbonaceous gases and fuel, or, in other words, the rapidity of melting; (3) the length of time the molten metal lies in contact with the coke in the furnace bed, and (4) the surface area per unit weight of steel exposed to the carburising influences.

Full consideration of these factors will show at once the possibility of wide variations in the car-

* Engineer, Nov. 27, 1916.
† J. E. Hurst, Proc., B.F.A., 1916.

bon content of the final product. Variations arising from these causes can only be prevented by the careful standardisation of the conditions of melting and the character of the scrap used in any individual set of circumstances. As an illustration of the variation due to different characters of scrap used in melting steel scrap alone in the cupola, three tests showing the carbon content of different melts are given below:—

| | | | |
|---|---|---|---|
| Jan. 4 | 2.25 per cent. | tot. C. | Steel turnings. |
| ,, 5 | 1.61 ,, | ,, ,, | Tinplate cuttings. |
| ,, 14 | 2.25 ,, | ,, ,, | Turnings and tunchings. |

The total carbon contents of published analyses of semi-steel mixtures vary within wide limits, but in no case of cupola-melted semi-steels do we find any reduction in total carbon contents proportional to the amount of steel added, as is imagined by many people. The fallacy of such imagination does not need any elaboration from what has already been said in the foregoing.

A series of typical analyses of semi-steel mixtures from two different sources are given in Table II:—

Table II.—*Composition of Semi-Steels.*

| | Cameron. (1) | | | Wheeler. (2) | |
|---|---|---|---|---|---|
| | D. | F. | G. | 25 per cent. steel. | 50 per cent. steel. |
| Tot. C. | 3.41 | 3.43 | 3.28 | 3.08 | 3.14 |
| Gr. .. | 2.90 | 2.85 | 2.69 | 2.45 | 2.30 |
| CC. .. | 0.51 | 0.58 | 0.59 | 0.63 | 0.84 |
| Si. .. | 2.45 | 2.12 | 2.38 | 1.41 | 1.27 |
| Mn. .. | 0.81 | 0.52 | 0.68 | 0.37 | 0.44 |
| S. .. | 0.052 | 0.038 | 0.058 | 0.10 | 0.11 |
| P. .. | 0.60 | 0.55 | 0.68 | 1.04 | 0.85 |

(1) Special Booklet by Cameron Roberton, Limited.
(2) Wheeler, M/r Assoc. of Engineers, 1921.

Careful investigation of these figures shows no serious reduction in total carbon contents over those present in normal pig-iron mixtures. The two samples by Mr. Wheeler are certainly low in total carbon content for this class of iron, but even here there is a higher total carbon content in the sample containing twice as much steel as the other.

### Effect of Steel Additions.

In so far as the total carbon content is concerned, it may be considered that there is little if any change in the amount of this present due to the addition of steel. In fact, in calculating mixtures it is perfectly legitimate to utilise a figure of 3 per cent. total carbon for the steel additions.

With the exception of the carbon contents, and also possibly the sulphur contents, the additions of steel to cast iron merely act as a diluent on the remainder of the constituents. In other words, the effect of steel additions on the silicon manganese and phosphorus contents of cast iron is to dilute them to an extent proportional to the amount of steel added, and the final composition of steel mixtures in so far as these constituents are concerned can be calculated on this basis, the usual allowances for losses on melting being made in the ordinary manner. Further, if the steel is assumed to contain 3 per cent. carbon and the usual allowances made for gain in sulphur contents according to the particular practice, the whole of the composition of a steel mixture can be calculated with tolerable accuracy.

It will be at once apparent that apart from the percentage of steel added, the success of the steel mixture for any given casting is really determined by the composition of the pig-iron employed in the mixture. The addition of 50 per cent. steel scrap to a basic pig-iron of 1.25 per cent. silicon content would give a final result of, say, 0.75 per cent. silicon, which would be a white iron unsuitable for most purposes. In a like manner the amount of steel scrap which can be used in the mixture is determined by the composition of the pig-iron portion, and just as in ordinary foundry practice it is necessary to determine the limits of chemical composition suitable for any particular class of casting and to adjust the composition or brand of the pig-iron used and the amount of steel added to obtain the desired result.

### Mechanical Properties of Semi-Steels.

There is no doubt whatever that the more extended use of semi-steel mixtures has gone a long way towards improving the character and quality of castings during recent years. This probably applies more particularly to general castings. In the production of general castings there has been a tendency to use too soft a grade of iron and, in many cases, too phosphoric iron. This arises from the desire to ensure castings of exceptionally good appearance and quite free from machining difficulties. The use of steel mixtures has had the effect of lowering the silicon and phosphorus contents to more reasonable proportions, with concomitant improvement in the mechanical properties, and without detrimental effect on the appearance, machinability, and soundness of the castings.

Many extravagant claims have been made for the improvement in mechanical properties effected by the addition of steel to cupola melted mixtures. An examination of the published results of careful investigators shows that the addition of steel scrap to any given mixture results in the gradual improvement of the strength properties. This is as would be expected from the reduction in the silicon contents, but the extent of the improvement will obviously depend upon the initial composition of the pig-iron used. The conclusion that any such influence is an intrinsic influence of the added pig-iron must be carefully guarded against. The most satisfactory figures are those published by Wheeler (*loc. cit.*), and as a result of his investigations on the addition of steel in increasing quantities from 10 per cent. to 30 per cent. to a soft cast iron, he was able to arrive at the conclusion that with each 5 per cent. of steel added to this particular mixture an increase of 1 ton per sq. in. tensile strength might be expected.

Whilst it is found that the effect of steel additions on the mechanical properties depends upon the amount of steel added, it must not be lost sight of that the effect is equally as much dependent upon the composition of the cast-iron portion of the mixture.

We have yet no clear evidence that the addition of steel scrap brings about any phenomenal improvement over cast iron of the same chemical composition cast under identical conditions. Some of the phenomenal results which are from time to time reported are as a rule unaccompanied by sufficient data to enable a correct opinion to be formed. It is probable that under certain conditions of irregular melting comparatively low total carbon irons are produced, and in such cases one would expect to meet abnormal mechanical strength properties.

In France, during the war, semi-steel mixtures were found to give good service as shell-piercing tools, and recently our own Woolwich Arsenal has found that semi-steel mixtures give very satisfactory life as ingot moulds for brass ingots. In neither case are any comparative data to be had over similar compositions obtained without steel additions.

### Some Practical Hints.

The great danger in the preparation of semi-steel mixtures in the cupola arises from the danger of irregular composition. The time element in the absorption of carbon by the steel, which is in its turn influenced by the character of the scrap and the temperature of melting, is the source of this danger. It is easy to imagine a variety of conditions in the foundry, such as irregular tapping off of supplies of molten metal, irregular settling of the charges, etc., which for the above reasons would tend towards irregularity of composition. This can be overcome by tapping off the whole of each charge separately into one ladle or by the use of a receiver. Careful control of the melting conditions, both as regards uniformity of melting and velocity of melting, is essential. The early method of preventing irregularity was the method of "twice melting," in which the original mixture was first cast into the form of rough pigs or plates and broken up for remelting before casting. This method is not often resorted to to-day.

The character of the steel scrap used has been the subject of much criticism, and from a general

point of view, more particularly for economic reasons, a medium weight scrap gives the best results. The use of steel turnings is very frequently condemned. The comparative ease with which steel borings and turnings can be melted does not appear to be generally recognised. Steel in this form offers the largest surface area per unit weight, and its advantage from this point of view will be obvious. Very finely divided turnings either throttle the blast or hang up the cupola or finish up in the spark arrester, and are consequently useless. In connection with the use of steel borings, the writer has melted many tons of these both *alone* and in mixtures in the cupola, and the only serious difficulty ever met with was that of handling this material. Steel borings are extremely useful where small quantities of semi-steel mixture only are required, and it should be needless to add that clean borings are essential and vigorous stirring of the mixture in the ladle is an advantage.

The use of white iron in place of steel in such mixtures eliminates the possibility of irregularity arising from the time factor in the case of steel. The effect of white iron additions is exactly identical to that of steel, and this in itself is positive proof of the absence of any intrinsic influence of steel in semi-steel mixtures.

Table III.—*Equivalence of White Iron and Steel.*

| Mixture. | | | | Composition. | | | Tests. | |
|---|---|---|---|---|---|---|---|---|
| Grey. | Mottled. | White. | Steel. | CC. | Gr. | Si. | Tensile. | Transverse. |
| 11 cwts. .. | 9 | — | — | 0.55 | — | 1.59 | 16.5 tons | 3,725 lbs. |
| 18 ,, .. | — | 2 | — | 0.66 | 2.88 | 1.82 | 16.3 ,, | 3,080 ,, |
| 15 ,, .. | — | 3 | — | 0.55 | 3.11 | 1.86 | 17.0 ,, | 3,770 ,, |
| 16 ,, .. | — | — | 4 | 0.57 | 3.27 | 1.91 | 17.0 ,, | 3,560 ,, |
| 14 ,, .. | — | 4 | 2 | 0.38 | 2.91 | 2.39 | 17.0 ,, | 3,775 ,, |

A series of results from a variety of mixtures containing both mottled and white irons and also containing steel are given in Table III, which serve to demonstrate the equivalence of white irons to steel for this purpose.

In concluding these remarks it is still of importance to emphasise the fact that semi-steel is a true cast iron in all senses of the word, and possesses properties no different from ordinary cast iron of the same chemical composition produced under identical conditions. The writer has been a fairly consistent user of steel scrap in cupola-melted mixtures for a number of years. Whilst strongly deprecating the title "semi-steel" and having no sympathy with the extravagant claims which have been made for it, the writer has no hesitation in recommending the use of steel scrap as a delightfully cheap and easy way of producing a low-silicon, low-phosphorus iron—a good iron.

## Foundry Query.

### Phosphor Bronze Spindles.

I am at present casting small spindles in phosphor bronze. The castings are about 6¼ in. long, with diameters varying from 1⅛ to 1⅝ ins. Teeth are cut at one end, forming a ratchet for raising a yoke in high-pressure steam valves, which are tested to 350 lbs. steam pressure. Part of the spindle is subject to this pressure, and we find the steam finds its way through the spindle and condenses or drips outside the valve. The alloy we use is Cu 91, Sn 8.5, P 0.5. The phosphor is added as phosphor copper. On breaking a defective casting the fracture looks rather mottled. It has been suggested that a small percentage of lead would remedy this. Possibly some of your readers may advise me on this point.—"Cuprum."

**National Federation of Iron and Steel Manufacturers.**—This Federation has issued a new edition of "Statistics of the Iron and Steel Industries," which follows in the main those issued in the last few years, but some tables have been added in the British Section. A table is also given showing the iron and steel imports of Australia. Under Germany, more details are given with regard to imports and exports. Poland has also a small section devoted to it.

## Institute of British Foundrymen.

### NEWCASTLE JUNIOR SECTION.

A party of about eighty members of the Newcastle Junior Section visited the ironfoundry of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, Close Works, Gateshead-on-Tyne, on March 14. The visitors were received by Mr. Weathers (manager), and were shown round by Messrs. Walsh, Nicholson, Elliott, H. and W. Scott, Bell and Clark.

This foundry, which covers an area of 6 acres, was visited by the members of the Institute during the annual Convention at Newcastle last year, and it was described in The Foundry Trade Journal dated July 17, 1924.

In the evening a meeting was held in the Neville Hall, Newcastle, when Mr. C. Gresty lectured on "The Effect of Casting Thickness upon Cast Iron," Mr. E. J. Rang, B.Sc., presiding.

In his opening remarks the lecturer pointed out that his subject was really part of the larger one of rate of cooling, as one necessarily involved the other.

Speaking of metals in general, he said that the greater the casting thickness, and, consequently, the slower the rate of cooling, the bigger the crystallisation. In the case of cast iron, however, there was one great difference from other metals, namely, the presence of graphite. Not only was the graphite itself larger in thick sections, but also there was more of it, *i.e.*, the actual composition of the iron, so far as graphite and combined carbon were concerned, altered with the casting thickness. A secondary factor, not unimportant, was the segregation of certain of the constituents of cast iron.

The lecturer showed numerous slides illustrating typical examples of the effect of casting thickness and rate of cooling, pointing out the difference between the metal of a test-bar and of the casting it represented. He also dealt with the solidification of cast iron when cast into thin sections and thick sections, explaining the mechanism of a "draw," which might occur at the junction of two sections of unequal thickness.

The effect of casting thickness on the mechanical strength of cast iron was reviewed by the author, who illustrated his remarks by a series of microphotographs, ranging from white iron at one end of the series to a very soft iron, containing no combined carbon, at the other end.

Speaking of segregation, the lecturer stated that phosphides in cast iron solidified at about 150 to 200 deg. lower than the rest of the metal, so that they were liquid for some time after the remainder of the metal had solidified. The result was that, as the crystals of iron grew, these molten phosphides were forced into the boundaries between the crystals, which was the cause of their characteristic triangular shape.

Sulphides also segregated in cast iron, but did not appear to have such a weakening effect as phosphides. As an indication, however, of the extent to which sulphides did segregate, the lecturer instanced the process used in some works for the desulphurisation of molten iron, which consisted of the addition of manganese and allowing the metal to stand until practically all the globules of manganese sulphide rose to the top.

The lecture was followed by a good discussion, in which the President and Messrs. J. E. O. Little, V. L. Banks, F. Allen, L. B. Chapman, C. R. Van der Ben, and C. Boudry took part, and a hearty vote of thanks was accorded to the lecturer.

George Craddock & Company, Limited, have removed their London office address to 32, Cavendish Square, W.1.

# Semi-Steel.*

By H. Field.

No apology is needed for adhering to the name by which every foundryman and most engineers still call this particular type of iron. That the name is indefensible on technical or metallurgical grounds is readily admitted, but it is nevertheless better than some of the complex and compound alternatives suggested. If it gives no idea of the ultimate properties of the metal it does at least give a truthful picture of the component elements of the mixture, and the time has long passed by when any but the very simple might buy it under the impression that they purchased a ductile metal.

The material semi-steel is in fact a cast iron made by melting together ordinary pig-iron and steel in varying proportions according to the work to be cast. The object of making this mixture is to produce from *cheap pig-iron* a final material with some or all the virtues of more expensive pig-iron mixtures, and inasmuch as these latter never give any ductility worth measurement, foundrymen neither expect nor obtain ductility in semi-steel. What is obtained is a very close-grained iron, with tensile strength improved in varying degree up to 50 per cent. increase, and transverse strength also improved in a lesser but nevertheless a valuable degree. The increased closeness of grain also gives to some extent an iron more capable of withstanding hydraulic or pneumatic pressure and the action of acids and heat. A consideration of these benefits enables it to be confidently stated that semi-steel is a valuable addition to the materials available to both engineer and ironfounder.

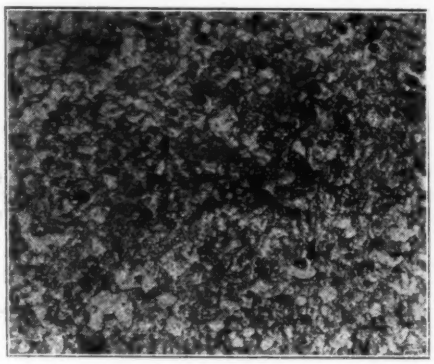

Fig. 1.—Mild Steel (C = 0.28 per Cent.) Used for the Experiments × 100 dias.

Fig. 2.—Mild Steel Recovered from the Cupola. The Piece was just on the Point of Melting. (C = 0.26 per Cent.) × 100 dias.

It has been frequently stated that there is no difficulty in making semi-steel, and while this is in the main true, there must be difficulties, since all who attempt do not succeed. It is not unknown to hear of engineers who will have no more to do with this material because in past trials they have found hard spots, even *white* sections and blow-holes. These are just as much the possible results of improper choice of materials and defective melting practice as they are acknowledged to be with ordinary iron.

The most ready method which suggests itself for making semi-steel is to mix together molten steel and molten cast iron, but such a method can only be practised where the materials are available. It might be supposed that under such conditions the ductile properties of the steel would be retained, since it has not been passed through the cupola, but such is not the case. Even if a soft grey iron be used, the resultant metal tends to be white in fracture if any considerable proportion of steel is used. It is, however, an excellent method for making strong, close-grained cast iron.

This method, however, evidently appeals to many foundrymen, and they use the nearest approach possible by adding solid steel to molten cast iron in the ladle, a method to be strongly condemned. The only quantity of solid metal which a given quantity of liquid metal can raise to melting point and convert into liquid is so small as to be without influence on properties. Should an attempt be made to use a larger quantity, say 10 to 20 per cent., the fluid metal is robbed of so much heat as to become useless, and is also filled with shots of partly melted steel. Scientific melting practice, *i.e.*, practice which seeks to do the thing rightly and to follow the same course from day to day, must look askance on the addition of solid metal to well-melted metal in the ladle. It is rarely that any molten metal has any surplus heat available for such work.

The air-furnace offers the best medium for melting semi-steel, because there the desired materials may be thoroughly mixed and melted and the mixture tested to ascertain if suitable for the work in hand. By this type of furnace a true low-carbon metal can be obtained, a difficult feat in cupola practice. This is an ideal metal when so melted for the purpose of chilled castings, rolls, etc.

Semi-steel melting on a large scale has been adopted by some makers of so-called refined and special pig-irons. The steel in this case acts as a diluent, proportionally reducing the quantities of phosphorus and manganese and to a slight extent in good practice the carbon, but as to whether or not a really improved metal for foundry practice is obtained by such a process depends on one important question—Do the improved properties obtained by melting steel with cast iron persist on re-melting?

### Cupola not a Mixer.

Semi-steel, like cast iron, is generally made in the cupola. Whilst it may be true to say that no special form of cupola is necessary, this statement is correct only because of the modifications wrought in cupola practice during recent years. The old-fashioned cupola, with its small-area tuyeres and hurricane blast, would indeed have produced a material hard and full of blow-holes had our forefathers used it for melting high steel-mixtures. If we accept present-day conditions of melting good iron, namely, a tuyere area about one-fourth the area of melting zone and a blast pressure of 12 ozs. per sq. in., with the requisite volume of air, then semi-steel may be safely melted under similar conditions. The hearth of the furnace should in all cases be sufficiently large to accommodate a complete charge when melted, as this mixture should not be run out at the spout until it has had some chance to become uniform. The cupola is not a metal mixer, and such mixtures as pig-iron and

* A Paper read before the Wales and Monmouth Branch of the Institute of British Foundrymen, Mr. P. Leonard Gould presiding.

steel, high- and low-phosphorus pigs, or pig-iron with rich ferro-alloys, should not be cast until they have had every facility for mixing both within and without the cupola. A very convenient method for small foundries is to mount a 5-cwt. shank on trestles before the cupola spout and run the metal from the furnace into the shank, and thence into the ordinary hand ladles, so using the shank as a receiver. A comparison between samples taken at intervals during a run under these conditions will show that successive casts are much more uniform than when taken direct from the cupola with hand ladles.

Strict attention must be paid to the choice of materials in making semi-steel. A comparison between the relationship of chemical and physical properties in a straight grey iron and a semi-steel shows that at once the increased physical qualities of the latter are due to some other influence besides that of the alteration in composition caused by the steel additions. Even so, there are two elements which must be adjusted on the same principles and with the same care as in ordinary iron. The influence of silicon on hardness and its regulation according to section undergoes no change because of the steel present, and the same is true of phosphorus and its relation to fluidity. Light castings in semi-steel must have high silicon and phosphorus as in grey iron, and the reverse is true for heavy work. It is therefore necessary to start with a pig-iron which contains a greater quantity of each of these elements than is finally required, since they will both suffer a reduction in precisely the same proportion in which steel is added, for the latter contains only a negligible amount of each. With high percentages of steel, it will be necessary to commence with a soft open-grained pig of high silicon-content, if the product is to be of machinable quality in ordinary sections and if the phosphorus is to be of the order of 0.8 per cent. in the finished metal, there will need to be over 1 per cent. in the pig-iron. It is also advisable to keep a fair percentage of manganese, say 0.6 per cent., in the finished semi-steel, but since most mild steel contains this amount, the steel addition will not rob the pig-iron, and an initial content of 0.6 per cent. manganese in the latter will be quite suitable.

To a large extent the increased physical properties are due to a reduction in total carbon, which is reflected in a decreased content of graphitic carbon, the most weakening constituent of cast iron. In fact, it is only by modifying either the quantity or quality of the carbon that any considerable improvement in cast iron can be obtained. To this end it is well to begin with a pig-iron low in carbon, and certainly not with hematite pig-iron, which is amongst the highest in this respect. The high-phosphorus pig-irons, which the author uses and recommends for this work, are generally lower in carbon than most other irons, although not lower than special cylinder pigs, themselves often made by steel additions. This reduction in total carbon is essential if the best physical qualities are to be obtained, but it often does not take place, and there is, in fact, an increase when the melting practice is not good. For this purpose it is necessary to keep the coke at a minimum, which in its turn can only be accomplished when the air supply is regulated, for excess air either demands excess coke or results in oxidised iron. It should be possible to melt with 10 per cent. of coke, exclusive of bed, and if this be much exceeded it will be difficult to effect a reduction in carbon and obtain strongest metal. The strength of semi-steel is very largely dependant upon the percentage of graphite, but this point is common also to ordinary iron; between 3.2 and 2.7 per cent. of this constituent it has been found that each 0.1 per cent. reduction is worth an increase in strength of one ton tensile.

### Character of Steel Additions.

The quality of steel to be used calls for attention. In his earliest experiments the author found that thin material, the waste from machine presses, is not suitable to use, for it suffers heavy oxidisation due to its relatively large surface, and to the rapidity with which it reaches an oxidising temperature. Foundries working in conjunction with engineering shops are often put under pressure to use this steel, but will be well advised to resist, or trouble will be encountered. This same material is, however, sometimes available in tightly compressed bundles, about 30 in. long and 6 in. square, similar to pig-iron in shape and weighing roughly ¾ cwt., and is then very suitable for the work.

Whilst superintending cupola work, the author has seen this very light steel become very highly oxidised, even before it disappears from view below the charging door, and on such occasions the slag will be black, the cupola lining very severely attacked, and the metal little, if any, better for its quota of steel. It is from such melting that castings spoiled by blow-holes are obtained, and only naturally so when the conditions in the cupola hearth are considered. Very small material, such as boiler punchings, is also condemned for semi-steel work. The least harm that it can do is to slip down through its companions of the charge, and so cause unequal proportions of steel at different points, whilst there is a possibility of a quick descent right through into the molten bath before complete carburisation is accomplished. In such cases the pieces are often only partly dissolved by the molten metal, and hard spots result; this again being a frequent cause of complaint against semi-steel. The ideal form of steel for general work in cupolas up to 40 in. dia. is the scrap from constructional work, plates, angles, etc., of about ½ in. thickness, and this steel can usually be relied on as regards composition. For larger cupolas, rail ends, etc., are used with success, but are not, in the author's opinion, so good as the constructional steel. The use of tool steel, files, etc., is usually condemned, but there seems no legitimate reason for so doing except the fact that such higher carbon material will have a lower melting point than mild steel. At any rate, it is evident that at some stage between charging and tapping the mild steel itself must contain just that proportion of carbon which is in tool steel; and, furthermore, what of the

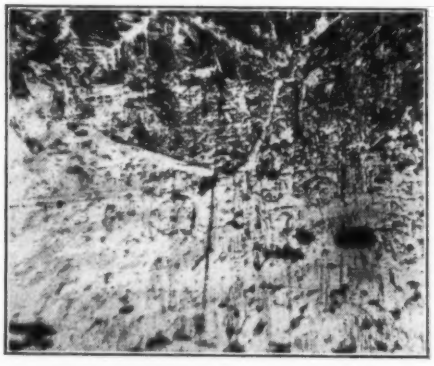

Fig. 3.—Similar to Fig. 2, showing the Decarburised and Oxidised Edge (Bottom) × 100 dias.

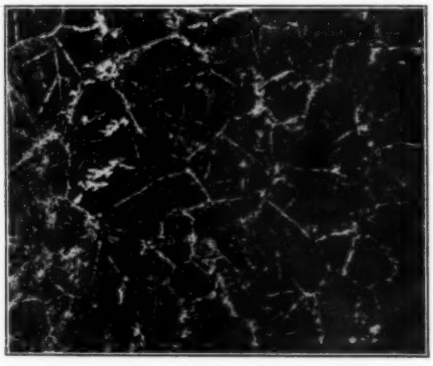

Fig. 4.—Microstructure of a Small Sample of Molten Steel Recovered at the Tuyères with a Spoon (CC = 0.82 per Cent.) × 100 dias.

3 per cent. of carbon in pig-iron? Moldenke[5] condemns the use of such steel on the ground that it gives trouble when exposed to high temperatures with only a little oxygen.

Various workers have stipulated that for best results the steel should have some definite position in the charge—above the coke, below the coke, or between pig and scrap. The experiments now to be described attempt to show what happens to steel in the cupola, and will have a bearing on the order of charging. Prior to these experiments, the author had held the view that the steel, gradually descending in the cupola shaft, was rapidly carburised on its surface in the solid state by gases or by solid carbon, and that when it reached a zone with a temperature corresponding to the melting point of such a high carbon metal, melting took place. Thus, with 1 per cent. carbon absorbed, melting would take place at 1,450 deg. C., with 2 per cent. at 1,380 deg. C., with 3 per cent. at 1,300 deg. C., as shown in the equilibrium diagram for the iron-carbon alloys.

### Cupola Experiments with all Steel.

The author, having a small drop-bottom cupola at his disposal, charged it with steel only, separated by small coke charges. Metal appeared at the tap hole in normal time, accompanied by a wild firework display, and the iron when cast was found to be hard, white in fracture, and full of blow-holes. The tap hole was kept open, so that the metal ran out as quickly as it melted, and did not lie in the furnace bottom. It showed an analysis 2.8 to 2.9 per cent. of carbon, all combined, and when annealed in a malleable oven, gave a reasonable ductile metal. No doubt the blow-holes could be eliminated by a deoxidiser such as aluminium. About half-way through the heat the furnace was drained and the bottom dropped, so as to obtain the remainder of the steel in the unmelted and partly melted condition. The metal so recovered in the form of plates 6 in. round, ¾ in. diameter, showed a thin scape of oxide, probably formed in the higher regions around the charging door, and when broken had the typical large crystalline fracture of burnt steel, although still quite tough and ductile. Samples were taken for carbon, but no increase was shown over the original amount in the steel, viz., 0.28 per cent.; this being true even of spongy pieces which were actually partly melted. Sections under the microscope showed instead the faint beginnings of oxidation at the edges, and beneath the oxide the carbon still remained at its original figure. Steel can be melted in the cupola, and during its descent from melting zone to hearth there is absorbed 3.0 per cent. of carbon.

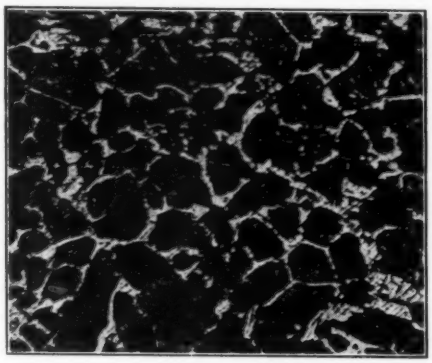

Fig. 5.—Cast Iron at the Tapping Spout (CC 2.90 per Cent.). It is the Result of Melting Steel in the Cupola.

This experiment was repeated, but arrangements were made to catch falling drops at the tuyere. For this purpose a small iron spoon lined with sand being used and pushed through the tuyeres. Four samples were taken progressively through the heat: the first two were hard and brittle, showing respectively 2.65 and 1.86 per cent. of carbon, the third was slightly malleable with 1.35 per cent., and the last quite ductile and soft with 0.82 per cent. carbon. These results suggest that the melting zone had gradually fallen during the heat, so that the metal was melting at a less height above the tuyeres, and in falling through a smaller range of incandescent coke, had absorbed less carbon. The author, like many other workers, has in view the production of malleable metal direct from the cupola, and if iron with 0.8 per cent. of carbon, which is certainly malleable, can be withdrawn at the tuyere level, it may be possible in a cupola with very shallow hearth to tap off a metal which is still sufficiently low in carbon to be of some service as a malleable product. It is of interest to note that the melting point of a pure iron-carbon alloy with 0.8 per cent. carbon is not much below 1,500 deg. C., and an indication of the temperature at tuyeres in cupola is thus given. In the first experiment the slag frothed up, and was just into the tuyeres when the cupola bottom was dropped; it showed $SiO_2$, 45; FeO, 30; and CaO, 17 per cent. In the second experiment, drops of slag caught at the tuyeres were found to contain $SiO_2$, 47; FeO, 33; and CaO, 10 per cent., whilst that tapped out after melting was much more normal with $SiO_2$, 55; FeO, 7.5; and CaO, 22 per cent. All these indicate the heavy risks of melting high-steel percentages, and show the necessity of avoiding an oxidising atmosphere. The results of the experiment are shown in Tables I and II.

The author has two samples of metal showing the result of melting light steel in a cupola, without any particular precautions being taken. They show 1.53 per cent. and 1.93 per cent. of carbon respectively, and constitute the lowest carbon cupola melted metal of which he is aware. Experiments are now in hand to improve upon these figures, and at the same time to obtain sound metal of commercial value.

Table I.—*Chemical History of the Carbon Content.*

| | Carbon. Per cent. |
|---|---|
| Original steel .. .. .. .. .. | 0.28 |
| Molten metal at tuyeres 1 .. .. .. | 2.65 |
| ,, 2 .. .. .. | 1.86 |
| ,, 3 .. .. .. | 1.35 |
| ,, 4 .. .. .. | 0.82 |
| Metal at spout .. .. .. .. | 2.90 |
| Partly melted steel, spongy.. .. .. | 0.26 |
| Steel from top charge, no signs of fusion .. | 0.28 |

These experiments very closely confirm those of Cameron[1], who found only very low carbon-absorption in semi-melted metal. On the other hand, J. Grennan, of U.S.A.[2], concludes that steel when melting in the cupola contains at least 1.25 to 1.35 per cent. carbon, with which the author's results do not agree, for some of the steel obtained by dropping bottom was clearly caught just at melting-point and shows no increase of carbon except on an edge of microscopic thickness. Moldenke[3] claims to have melted many tons of steel for castings in a cupola, using two to four times the usual amount of coke, a precaution necessary to avoid scaffolding through solidification of low-carbon material. It is doubtful if such metal can be cast free from blowholes without using a deoxidiser, such as aluminium.

Table II.—*Slag Conditions.*

| | FeO. Per cent. |
|---|---|
| Slag—frothed over into belt .. .. | 30 |
| ,, caught at tuyeres .. .. .. | 33 |
| ,, tapped at spout .. .. .. | 7.5 |

Since, then, steel melts with the absorption of little or no carbon in the cupola, there is no need to place it either above or below the coke in order to bring it in contact with the solid carbon. In fact, the carbon which may be absorbed in its solid state is certainly the result of contact with gases rather than with coke or solid carbon. Thin steel, provided it is not oxidised in descent, will melt quicker than grey pig-iron, and this is probably true of any steel under 1 in. in thickness. The order of charging may be determined as in straight pig-scrap mixtures with this proviso, that steel over 1 in. to 1½ in. thick be treated as pig-

iron and charged with it, whilst in thinner sections it should be above the pig-iron either second or third in order, according to its relation to the scrap.

In casting semi-steel, provision must be made for an increased shrinkage over grey iron. This applies to both liquid and solid shrinkage, for semi-steel is more prone to those defects known as "draws and shrinkages" than is straight grey iron. Larger feeding heads are required and increased fillets in angles, and it must be admitted that this tendency to draw is one of the most serious troubles with these mixtures.

The analysis and physical properties of a series of semi-steels are shown in Table III, the amounts of steel used being 10, 20, 35, and 50 per cent. respectively, and the pig-iron, No. 3 Sheepbridge, which may be regarded as a normal foundry iron. The author's purpose in using steel has always been to improve the properties of the cheaper pig-irons and bring them up to the level of the better class irons, thus producing a high-grade material at lowest cost. Steel can be bought at quite as low a price as Northampton or Derbyshire pig-iron, and by the production of such mixtures as those now outlined an iron of excellent physical properties costs less than £5 per ton. Not only so, but the improvements obtained with high-class iron as a base are much less noticeable than with cheap irons, and high steel-percentages cannot be used with low-silicon irons.

The mixtures consisted of steel, pig-iron, and ordinary foundry scrap in the proportions shown in Table III, the scrap containing a large proportion of Sheepbridge iron and showing about 2.8 silicon and 1.4 per cent. phosphorus. The silicon was kept as nearly constant as possible, within the limits allowed by the three materials chosen. Manganese is fairly constant, and phosphorus drops regularly in proportion to the diluting effect of the steel. The percentage of total carbon also shows a continual decrease, and these mixtures may on this account claim to be well melted and to be true semi-steel, for with indifferent melting the high-steel mixtures might easily show no reduction in carbon and give consequently lower tests. The combined carbon shows a gradual increase more pronounced in the 50 per cent. mixture, but the combined effect of this increase taken together with the falling total carbon is to give a very rapidly diminishing graphite content, amounting to 27 per cent. in the 50 per cent. steel mixture. This is a most important factor in the improvement of the metal.

Table III.—*Analysis and Properties of Semi-Steel.*

| | | | | |
|---|---|---|---|---|
| Pig-iron .. .. | 65 | 55 | 45 | 35 |
| Steel .. .. .. | 10 | 20 | 35 | 50 |
| Scrap .. .. | 25 | 25 | 20 | 15 |
| *Analysis:* | | | | |
| Silicon .. .. | 2.65 | 2.25 | 2.20 | 2.0 |
| Sulphur .. .. | All under | 0.08% | | |
| Phosphorus .. | 1.38 | 1.14 | 1.01 | 0.91 |
| Manganese .. | 0.63 | 0.51 | 0.57 | 0.51 |
| Combined carbon | 0.33 | 0.35 | 0.37 | 0.57 |
| Graphitic carbon | 2.92 | 2.72 | 2.53 | 2.13 |
| Total carbon .. | 3.25 | 3.07 | 2.90 | 2.70 |
| *Physical Properties:* | | | | |
| Tensile strength tons | 11.9 | 14.4 | 16.0 | 18.3 |
| Transverse ,, lbs. | 2.600 | 3.025 | 3.360 | 3.640 |
| Deflection ins. | 0.090 | 0.106 | 0.119 | 0.110 |

The physical properties improve steadily with the increase in steel, the increase in tensile being 54 per cent. and in transverse 40 per cent. It is particularly noticeable with what regularity the improvement takes place, and it does not seem that there is an abrupt limit to the amount of steel which can be usefully added, and certainly not with this particular pig-iron. The tensile bars are cast $\frac{7}{8}$ in. dia. and machined to 0.564 in., the transverse bars 12 in. by 1 in. by 1 in. It is admitted that tests on this size of bar give a false idea of the value of this metal for heavier work, but they are comparative, and are of a section equal to that of the general run of castings at the author's foundry. The improvement in transverse strength is distinctly encouraging, as it is often stated that there is no improvement in this test, but it is conceded that such improvement may be largely due to the gradual reduction in phosphorus, and would take place in some degree if this element were similarly reduced in any manner other than by steel additions.

All irons were readily machined at normal speeds in the $\frac{7}{8}$-in. size, and the machinist was unable to detect any hardness greater than in the ordinary grey irons which he regularly works upon, except in the case of the 50 per cent. one, which was rather hard. There is no difficulty in making 50 per cent. semi-steel, with high-phosphorus and low-carbon, suitable for light castings and easily machinable, provided that the silicon is kept at a sufficiently high figure. This is the obstacle over which many foundrymen stumble; a pig-iron of close grain and low-silicon is chosen for mixing with steel in the belief that this is the best basis for the production of a strong material, and the final metal with its silicon reduced more or less by steel addition is consequently too low to give softness, with the result that the mixtures are condemned as impracticable. The pig-iron, on the contrary, must be of a much softer and more open grade than would ordinarily be used for the work in hand, and if over 25 per cent. steel is to be used there should at least be 1 per cent. silicon in the pig-iron. This, of course, refers to heavy work.

There is nothing difficult about the law governing this point; it is simply a case of the laws of proportion and average. Steel contains no silicon, or, at any rate, an inconsiderable amount, and it reduces the silicon in the mixture, over and above

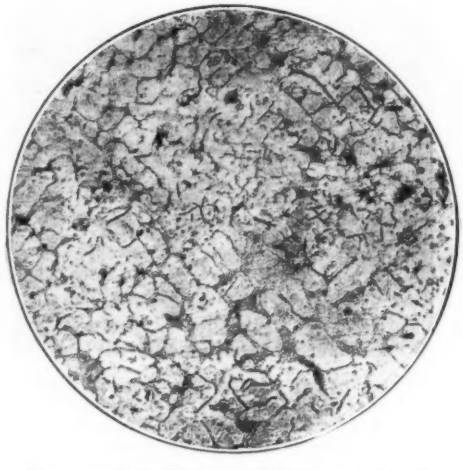

Fig. 6.—Semi-Steel × 100 dias., highly Etched to Reveal Graphite.

the ordinary melting losses, by precisely the proportion in which it is added thereto. Some workers have concluded that high-phosphorus pig-irons are unsuitable for using in semi-steel mixtures, and the author has therefore especially chosen this series, made from such a pig-iron, for detailed consideration. It is difficult to see what greater improvement could be expected if hematite iron were used, but, so far as the author's foundry requirements are concerned, the metal would then be unsuitable, as it is there often used for the lightest types of casting of the order of one or two ounces in weight and $\frac{1}{4}$ in. thickness. For such work there must be a final phosphorus content near 1 per cent. to give necessary fluidity and life, and the silicon must always be over 2 per cent. It has not yet been possible to use 50 per cent. steel in such work owing to high combined-carbon and consequent hardness. This difficulty can be easily understood when it is seen that in a $\frac{7}{8}$-in. test bar the average combined carbon reaches 0.57 per cent., and would be considerably higher on the skin.

### Physical Properties of Semi-Steel.

The physical properties recorded show improvements on materials of similar analysis made without steel, except that it would be difficult in a cupola to produce for comparison a low-carbon

material like the 50 per cent. sample by any method other than steel addition and give the required softness. Carbon reduction alone is not responsible for the increase in properties; the author daily melts on the same cupola first of all several tons of 10 per cent. semi-steel, which gives 14 to 16 tons tensile, and afterwards a quantity of grey iron which shows about 11 to 12 tons. The pig-irons are the same, although rather more pig and less scrap are used with the steel, and the final analyses, including both total and combined carbon, are also the same within ordinary working limits, and yet the steel mixture shows always from 3 to 4 tons added strength. Reverting to the series shown in Table III, the only constituent other than carbon which varies to any extent is phosphorus, which it has already been admitted may in part be responsible for the improvement in transverse strength. The same does not hold true for tensile strength, which within the author's experience is not influenced in any marked manner by rise or fall in phosphorus, and in his opinion it is possible to obtain equal tensile strength notwithstanding the phosphorus.

Figs. 1 *et seq.* show the structures of the 20 and 50 per cent. mixture, and a straight grey iron mixture of approximately similar anlysis for comparison. This series taken at 100 magnifications presents a range from 12 to 18 tons tensile. There is no greatly marked difference in the size of graphite, although in the stronger bar this is indeed a little smaller; on the other hand, there is a noticeable decrease in its quantity as steel increases, and also in the general compactness of structure and network effect of the phosphide eutectic. These sections were only very lightly etched in order to leave the graphite prominent; the arrangement of phosphide eutectic is more clearly shown in a further etching (Fig. 7), which depicts the 50 per cent. mixtures.

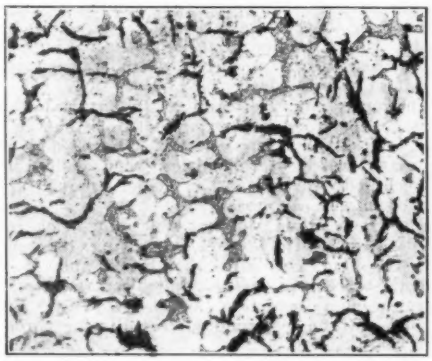

FIG. 7.—50 PER CENT. SEMI-STEEL HEAT-TREATED FOR 12 HOURS AT 800 DEG. C. × 100 DIAS.

Whilst most workers have agreed that the fine graphite is a necessary constituent of strong semi-steel, the Editor of THE FOUNDRY TRADE JOURNAL has gone further in using this characteristic as a basis for his definition of semi-steel. He submits the following:—"Semi-steel is a cast iron which has had its graphitic structure modified—that is, made finer—by the incorporation of steel into the charge during its manufacture." This would be an excellent definition, inasmuch as it would preclude the putting forward of mixtures containing only very low percentages of steel or of cold cast metal which does not show such fine graphite, but the author questions whether it is at all workable. Ironfounding has not yet reached the stage at which its products may be either accepted or rejected by a microscope test, although the advent of Lanz pearlitic cast iron may be one more step towards such an end, and, furthermore, no such definition as the above could be adopted without standardising the terms fine and coarse graphite. It does not seem necessary to so define semi-steel or to insist on the modified graphite, so long as the required improvement in physical properties is obtained and if both transverse and tensile strength show increases of 25 per cent. over the same mixture without steel, then genuine semi-steel has undoubtedly been produced.

For heavier work such as that familiar in South Wales the lower steel-mixtures are not suitable, as their grain would be too open in thicker sections. The stronger mixtures are, however, used very largely in these cases. This is especially so in U.S.A., and foundrymen are familiar through their literature with the breadth of adaptation which foundrymen there have found for semi-steel. It is used for all their large machinery, agricultural work, and for chilled car wheels and chilled rolls.

The high steel-mixtures respond well to heat treatment, of the order of 12 hours at 800 deg. C., and produce an iron which takes a permanent set under the bending test and can be quite easily riveted. Fig. 7 shows such a bar from a 50 per cent. steel mixture which gave 14.1 tons tensile strength and 3,250 lbs. transverse after 12 hours' annealing. The pearlite has all disappeared, and the whole area is occupied by ferrite and graphite, the latter being of much greater size than in the "as cast" condition. Such a material is often very useful in light engineering and electrical work.

### Casting Temperature.

It is well known that all classes of cast iron give best test results when cast hot, but these steel mixtures are particularly sensitive to temperature, and cold metal will cause all the beneficial results of the steel to be lost. Iron which gives 14 to 16 tons tensile when properly cast will yield only 12 tons at lower temperature, and this is due to a growth both in the size of graphite and in the general grain structure.

TABLE IV.—*Re-melting of Semi-Steel.*

| —— | Semi-Steel. | Grey Iron. | Sheep-bridge and Semi-steel. | Sheep-bridge and Grey Iron. |
|---|---|---|---|---|
| Silicon .. .. .. | 2.60 | 2.97 | 2.86 | 3.22 |
| Sulphur .. .. | 0.072 | 0.086 | 0.065 | 0.070 |
| Phosphorus .. .. | 1.44 | 1.63 | 1.47 | 1.61 |
| Manganese .. .. | 0.59 | 0.67 | 0.61 | 0.70 |
| Combined carbon .. | 0.35 | 0.30 | 0.30 | 0.30 |
| Graphitic carbon .. | 2.49 | 2.87 | 2.78 | 3.0 |
| Total carbon .. .. | 2.84 | 3.17 | 3.08 | 3.30 |
| Tensile strength, tons | 14.5 | 12.5 | 12.0 | 11.7 |
| Transverse strength, lbs. | 2.860 | 2.410 | 2.700 | 2.600 |
| Deflection, ins. .. | 0.100 | 0.117 | 0.099 | 0.110 |

### Remelting Semi-Steel.

In making high steel-mixtures, the result of a first melting of steel and pig-iron is often put through the cupola to make a more uniform material, or a very high-steel pig is diluted with further pig-iron to the required degree. Similar procedure is adopted when "refined" pig-irons, which are actually nothing but common pig-iron with steel, are purchased and used for the best classes of castings. If the most important constituent of good semi-steel is the fine graphite induced by the introduction of steel into the cupola charge, then on what ground can it be claimed that pig-irons above referred to will retain their maximum properties after that remelting which is necessary to convert them to castings? Any increased value due to low silicon, low phosphorus, or even low carbon may be retained and reproduced after remelting, although in the case of carbon there will be an increase if the percentage is less than that normally found in cupola-melted materials, but a claim that fine graphite could be reproduced would be refuted by the general belief that all carbon in molten iron is in solution, and even if that be not the case, it has been seen in the paragraph on heat treatment that rapid growth in graphite takes place with a temperature much lower than that to which the iron will be exposed in its descent of the cupola. The author is not quite clear how the fine graphite is originally produced—it appears to be the result of breakdown of fine structure cementite and eutectic in the just solidified material—but certainly the conditions on remelting are quite different, for there is then no steel as such present in the charge. Experiments seem to show a balance of evidence against the retention of either fine graphite or maximum physical properties after

remelting, and the result of one such experiment is outlined in Table IV. Semi-steel and grey iron of known physical properties were carefully cast into pig form, and each was then remelted with pig-iron under conditions as nearly identical as works practice would allow. The results on the two new materials so obtained are very nearly equal, and it is constantly observed in works practice that foundry scrap from castings in either grey iron or semi-steel may be indiscriminately mixed and again used in the production of either mixture without prejudicing the results in any way. It would be unfair to criticise on these grounds all so-called "refined pig-iron," but it is perfectly legitimate to issue a warning note against any which owe their enhanced properties to steel additions alone.

The author desires to thank Messrs. John Harper & Company, Limited, Willenhall, Staffs, for permission to publish the results of experiments made at their works.

### References.

(1) Inst. Brit. Found., 1921-22.
(2) American Found. Assocn., Reprint 411, Oct., 1924.
(3) Principles of Ironfounding.
(4) "F.T.J.," September 13, 1923.
(5) Principles of Ironfounding.

## DISCUSSION.

Mr. Gould thanked Mr. Field for his very interesting Paper and asked for discussion.

Answering Mr. McClelland, Mr. Field said he had never tried melting semi-steel in a crucible.

Mr. Hird said he thanked the lecturer for upsetting some of the theories about what happens to steel in the cupola. Many have concluded from the iron-carbon diagram that heat generated in the cupola does not reach 1,500 deg. C., and therefore steel must absorb carbon until it reaches about 2 per cent. and then come into line with the diagram. However, it seems that even opposite the tuyeres, the steel takes up very little carbon, and he would like to know if Mr. Field had come to any conclusions as to when the carbon is taken up.

Mr. Field replied that it was his opinion also before he started his experiments. It seems that the carbon is absorbed after the steel is melted and during its descent. In every case the proportion of carbon had been absorbed before it reached the tuyeres. An account entirely devoted to this subject will be found in the recent transactions of the American Foundrymen's Association, by Grennan. Cameron obtained results as low as 0.6 per cent. carbon when following the same method.

Mr. Padfield said he always felt grieved to read how far advanced such countries as the U.S.A. and Canada were over our own in the use of such materials as semi-steel, etc.

Mr. Evan Henry Davies asked if Mr. Field had in mind a better type of cupola; for instance, would a Machelle type be more suitable for making semi-steel?

Mr. Field said that a receiver would ensure proper mixture of the metal. Even when steel is melted, it is a greatly different form of metal from pig-iron, and he would not advise it being taken from the cupola in ladles. It should be taken from the shank into hand ladles. He had not had any special form of cupola at his disposal.

Mr. Hird asked if the cupola referred to by Mr. Davies was one with the receiver directly underneath? He had had one at Peterborough and one at Reading, and they had many advantages, and semi-steel had been melted in them very successfully, and this type of cupola should be very useful for making experiments.

Mr. McClelland thought the question of a receiver was a debatable point. He had worked a cupola with a receiver, but would never have another. In melting semi-steel it is necessary to maintain a high temperature, and when using a receiver there is a tendency to reduce the temperature of the metal. In his opinion, the spout ladle was far preferable to the receiver. In using a receiver it is quite natural for all the dross to come down into it, and although there is usually a slag spout, much will accumulate, and at the tail end of the blow will settle in the receiver and will not come off easily. It is nearly one man's work to look after the receiver, whilst the spout-ladle obviates all this.

Mr. Hird said that up to a point he agreed with Mr. McClelland. With some type of cupola there is much trouble with the slag, but with the Machelle type this trouble is more or less eliminated. If the slag spout is opened when starting blowing, heat passes down and warms up the receiver, constituting a considerable advantage, as otherwise there is invariably a cold receiver. He often wondered why this type of cupola had not been taken up more.

Mr. McLean asked why the adding of steel to the ladle was condemned if it was made hot?

Mr. Field insisted it could not be managed in large foundries.

Mr. McClelland remarked that Mr. Field had said that it was detrimental to use thin sheet metal in making semi-steel. Some thirty years ago, whilst in the U.S.A., he was making a kind of semi-steel by tapping the metal into the ladles and then adding turnings. On the question of American practice, he asked, did Mr. Field think there was any difference between American pig-iron and that purchased in this country? Mr. McClelland's experience was that there was a far superior class of metal available in America.

Mr. Field said that he did not think semi-steel was a commercial proposition when using expensive pig-iron. If starting with common pig-iron there is a considerable difference.

Mr. McClelland said that it was the custom in South Wales to use cold blast or hematite iron. Would Mr. Field recommend semi-steel in preference to these materials?

Mr. Field replied that he was making semi-steel from cheap pig-iron which was equal to hematite or cold blast.

Answering Mr. Deweann as to how a low percentage combined carbon would work out in the case of chilled castings, Mr. Field said that he experienced no difficulties when called upon for chilled castings. The chief point about semi-steel was *cheapness*.

Mr. Hird asked whether a syphon brick could be used successfully? When melting 100 tons a day the slag got into the brick and it was difficult to remove. When the blast was shut off there was a complete stoppage. Mr. Field replied that he used one successfully for three or four years.

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At the annual meeting of the Institute of Marine Engineers, Lord Inverforth was elected president for the year 1925-6. The remaining officers for the year 1925-6 were elected as follows:—Vice-presidents, Messrs. B. P. Fielden, J. M. Dewar, J. McLaren; members of Council, Messrs. A. H. Mather, R. S. Kennedy, W. E. McConnell, J. G. Hawthorn, D. A. Stewart Lee; hon. treasurer, Mr. A. Robertson; hon. secretary, Mr. Jas. Adamson. Mr. B. P. Fielden, as chairman, expressed the opinion that, considering that the Institute was doing work of national importance, it should not be called upon to pay income-tax. The annual report gave the total membership of the society as 2,880 on January 1, 1925, a decrease of 152 as compared with the previous year.

The members of the Scottish Section of the Institute of British Foundrymen held their annual meeting in Glasgow on March 28, Mr. J. Affleck presiding. Mr. Bell, secretary, in submitting the annual report, said that steady progress had been made during the session. The Scottish Section, he said, had at present on its register 5 honorary and life members, 48 members, 118 Associate members, and 26 Associates, making a total membership of 197. Much importance was attached also to the joint meetings which had been held by the Foundrymen's Institute and the Institution of Mechanical Engineers, when the subject discussed was the best methods of making castings for Diesel engines. These meetings so far had done little more than state the case for both sides, but the great step forward for foundrymen lay in obtaining acknowledgment that they had a case. In entering into a discussion with a kindred society on this matter they could reasonably claim to have made a material contribution to the subject. A discussion afterwards took place on a paper read at the previous meeting by Mr. E. J. Ross, Holm Foundry, Cathcart, on "Foundry Planning for Economical Production."

# Oil-Sand Cores.*

By G. Edginton (Broadoaks Foundry, Chesterfield).

It has been the author's experience that attempts to introduce oil-sand cores into foundries has been either an unqualified success or a dismal failure. This may be due to several things, as, for instance, they may have tried with an unsuitable core oil, or perhaps with sand not properly prepared. Probably, however, more often it is due to lack of enthusiasm and perseverance on the part of the foreman and coremakers, associated with an unsympathetic pattern shop, some of which have a great dislike to new ideas.

There is nothing mysterious about the production of oil-sand cores, and, given suitable equipment, every foundryman should be able to produce these cores successfully, but it should be pointed out that one cannot expect to train men into new methods in a few days. Patience and perseverance are necessary for a time, but those who do persevere will be amply repaid for the trouble, as cores can be made much easier and better. Intricate and difficult cores produced by these methods are foolproof, and a considerable saving in defective castings is effected.

### Type of Sand Used.

The finer sands are preferable, as they give a much better skin to the casting than the coarser sand, and are more easily rubbed and radiused after baking. Additionally, finer sands stand up better in a green state, the grains having closer contact than the coarser sands. This is readily found by making additions of water to the two sands. By making two cubes of the same volume it will be found the fine sand will carry much more water than the other before collapsing. In using reclaimed sand from the cleaning shop, care should be taken to keep the sand as clean as possible, and not to mix with loam or other sands from the castings, as this interferes with the venting properties. The practice is to shake out the sea-sand cores at one point. The castings are then taken farther on for final cleaning. This ensures the sand being kept quite separate.

### Preparation of the Sand.

Foundrymen in the Lancashire area are more fortunate than their colleagues in the Midlands, through having good clean sand quite close to their foundries. The sand at most places along the Lancashire coast is ideal for the purpose.

Should all sand be dried before mixing with the oil? Some writers advocate drying the sand, then mixing the oil with water into an emulsion before adding it in definite proportions to the sand. This is perhaps satisfactory with very small quantities, but when quantities of sand up to 10 and 12 tons per day has to be dealt with, it becomes a costly item. From experience, it is totally unnecessary, and extremely expensive. However, it is preferable that the sand should be stored under cover. The author's method is to bring the sand in from storage, spread out on plates, add 30 per cent. of reclaimed sand from the cleaning shop, and to make the addition of the oil. It is then turned over once before passing through a machine of the revolving type with paddles. As in the spring, when the sand is overloaded with moisture due to weather conditions, the foundry sometimes has to dry a small quantity for use the following day, but not often, as the sand reclaimed from the cleaning shop is usually more than sufficient.

The proportion of sand to oil for general work is 40 parts of sand to 1 of oil *by volume*. For steel castings and more delicate cores about 25 to 1 is used. It is better to use a more refractory sand for steel castings, and washed silica sands are best for this purpose; the venting properties of these sands are excellent, and in making the cores few vents are required. It is more than two years since any wax wire has been used in the author's foundry. There are several methods of mixing the sand. Presumably, there is hand mixing by riddling through the hand riddle. This is both costly and tedious. For large quantities, however, the mechanical riddle is quite good. The pan mill is considered as unsuitable, because it crushes the grains and destroys the venting qualities of the sand. The centrifugal mixer is apt to get "made up" too often through the sticking of the oil-sand to the blades and setting very hard The paddle mixer is designed to give the cutting and spreading action of the sand, and is probably the most efficient. It distributes the oil well, and does not crush or grind the grains like the pan mill, and gives better results with less oil used.

### Core Oils.

A good core oil should be adaptable to heavy or light, delicate cores, according to proportions used, and should not be offensive when baking. It should have good drying properties throughout, without running to the bottom of core, leaving a sticky mess. It should not take up moisture easily, whilst it must allow of cores being stored indefinitely. A core oil must only give a small gas production, so as to allow the metal to lie on cores without agitation, scabbing or blowing. It must permit of rapid combustion after casting, and allow the cores to crush readily so as to assist contraction, and finally, there must be complete destructibility to save labour in cleaning shop.

### Preparation of Boxes.

Close co-operation must exist between the foundry and pattern shop, as interchange of ideas as to the "best way" very often brings about a money saving in both departments, and the success in the making of oil-sand cores depends very largely on this being carried out. Core boxes must be made so that pieces can be taken away easily without disturbing the sand while in its green state. For this reason only a half-box is now made where formerly a full box was supplied. This gives a flat surface for turning out on to plates. Considerable advantages accrue from this. In some cores it is found that they can be made in quite 100 per cent. less time than when making the core all in one piece. Only loose irons are used where the making of the arbours is quite a big job. In one particular job, using oil sand, a man made a set of cores in seven hours. This was for three cores made in six halves. It was considered by the men quite a good day's work to make one core by the old method. In addition to this, four hours was saved on each casting for making core irons. Also, the difference in making a half-box and a whole one is a considerable saving of time and timber in the pattern shop.

This sand readily lends itself to the jointing of cores made in halves, but it is not always considered necessary, as the joints are usually so good they do not show when cast. Where there is an overhanging piece, over brackets and ribs, etc., the brackets or ribs are made in sand instead of timber. That means the patternmaker gives the core-maker a core box from which he makes the rib or bracket in sand. These remain in until the core is baked, and are then easily removed. These pieces serve for quite a number of cores. This method saves irons, and is very much quicker, for when the core is once dry it is very strong and will not "come down." Core boxes are better when varnished, as this prevents any sticking of sand. The core boxes last much longer with this method, as they are not damaged by the rammer and rapping.

### Making of Cores.

When making large cores, they are handled as little as possible, when in the green state. On the core carriages there are plates with machined surfaces. The core box is placed on this; the core is made, and the box removed, and so on, until the carriage is full. This is a distinct advantage with oil sand, as the plates are warm and the cores quickly stiffen up before the carriage is

* Paper read before Lancashire Branch of the Institute of British Foundrymen, Mr. R. A. Miles presiding.

moved, and there is therefore less liability of breakages. Also, it is not necessary to use all oil sand; if the box is lined with about 1½ in. of sand, then filled up with cinders and old shop-sand, considerable material and drying can be saved.

Vent holes must be left in the top of cores, to allow steam to pass out. This is very important, as oil cores become very hard on the top surface soon after being stoved, which traps the steam inside, and does not allow the core being properly baked. This is unnecessary with the smaller cores, and no vents at all are used for quite a number of jobs. Core-iron making is cut down to a minimum, and nowadays a set of cores is often made in the time previously taken to make core irons. Old feeding rods, and lifters with a hook or bowed iron, constitute the normal tackle. For repetition jobs a set of irons are made, but the sand shakes away so easily, the irons can be used a number of times without any breakages; therefore the saving in time through the elimination of the making of core irons in a large concern like the Broadoaks Foundry is very considerable in the year. Also, these cores can be made much quicker than by the older method, as no ramming is required. The sand is pushed in box with hands, or pressed down with the feet in the case of the larger cores. Thus the boxes are not damaged by the rammer, and, what is still more important, they are not distorted, which in many cases involved hours of rubbing for the moulder before he arrived at the required thickness and shape.

Another useful method of applying this sand is the making of the cope portion of moulds with it instead of using a box part. Such parts can be made very quickly, and produce a much more accurate casting. In jobs where the thickness of metal is 2 in. or more, it is important that the blacking should be used rather thicker than normal and rubbed on well with the hand, as the oil prevents the blacking getting into the face of the sand.

### The Baking of Cores.

The best temperature for drying these cores is from 300 to 400 deg. F. (150 to 200 deg. C.). Up to the present time the Broadoaks Foundry has not erected any special stoves for this purpose, and what is done to keep the smaller cores farthest from the fire, which is an open one, but as there are three core stoves, the larger cores are put in one stove and smaller ones in the others, according to size.

Our practice, based on experience, is to fire four hours for the bigger cores, then the heat in the stove does not rest. Formerly for the same kind of cores it was customary to fire 10 to 12 hours, so the saving in fuel on three stoves obviously must be considerable during a year's working. It is better to under-bake rather than otherwise, and stoves where temperature can be controlled are much more suitable than others, but if the cores get slightly burnt on the tops, a wash over with a mixture of oil and water will correct them. When the cores are properly baked, they present a strong, rock-like substance, which can be handled with ease, with no fear of breakage when turning over the core, as is sometimes necessary. These cores do not scab and are foolproof. Many foundrymen know the disappointment and set-backs due to someone breaking cores after a big job is partly assembled, involving the work being held up while another is made. This is quite impossible with these cores with anything like fair usage. Also, when cast, the oil bond burns itself out, leaving the casting much more freedom for contraction than formerly, and cracked castings are very rare. This is important, especially in steel castings. The Broadoaks Foundry is doing very little bracketing in their cores, and it is very rarely they have a "pull." With one type of core no core irons are used; the inside can be filled with any kind of material, such as a mixture of weak sand and sawdust, then, as the oil bond burns out, it will allow free shrinkage without setting up any strains to pull or crack the castings.

Much doubt seems to exist as to the amount of pressure and thickness of metal wherein the cores can be used with safety. In some cylinders, which are 2¾ in. thick in the bore, 1½ in. in the valve box and ports, weighing 11 tons 10 cwts. when cast, and are 11 ft. deep, from the runner box to the bottom flange, the pressure at bottom of the cylinder is approximately 30 lbs. per sq. in. These cores used, however, come out with nice clean surfaces. In big drums weighing 25 to 28 tons the metal in the boss is 9 and 10 in. around the centre core. These jobs are cast as a whole casting, with splitting core between the two halves; the core is only 2 in. thick and about 4 ft. deep; the cores stand up, and give a good, clean split, as does the centre core. It should be borne in mind that this part of casting is fed for two hours.

Another use to which these cores are put is for the boss cores of big pithead pulleys. The cores were formerly made in core sand, and when the rim was cast the contraction of the arms caused them to close into the boss, which was not cast until later. The action of the heavy arms closing in used to break down the loam sand very badly, and it was quite a big job to repair these before the boss could be cast. Since introducing oil sand this trouble has been entirely eliminated. The arms rub over the surface like passing over a sandstone wall, and no breakage occurs, and a better-looking casting results. Some of these boss castings weigh 3 tons, and there is not more than 4 to 5 in. of sand on the outside.

By making cylinder cores and other special cores in oil sand it enables one to apply unskilled labour to the jobs, as there are no vents to take care of.

Considerable time is saved in cleaning the castings, the cores being shaken out very easily. The coring of cylinders, block pistons, etc., which were regarded as special jobs, have become quite ordinary to the cleaners.

Summarised, the advantages shown are:—(1) Pattern-shop costs are reduced, as less timber is required, and by boxes lasting longer; (2) time is saved in making core irons, which is considerable; (3) the saving in fuel is quite 50 per cent.; (4) cores are made quicker and better, which brings about increased output through wasters being reduced, by less scabbing and blowing from cores; and (5) cleaning shop costs reduced considerably.

One reason for the author's taking up production of oil-sand cores on a fairly large scale was because his principal, Mr. Charles Markham, has a strong experimental turn of mind, and his idea was to wash loam cores out of castings by hydraulic pressure. This was not very successful, although there was a fairly high pressure of water available. It made a messy job, and the author is pleased to say Mr. Markham never troubles about hydraulic pressure now, as the result of using sea-sand and oil has made the cleaning of these castings such a very easy matter.

## Patent Specifications.

*Particulars of complete specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of Lonsdale Chambers, 27, Chancery Lane, London, W.C.2. Printed copies of the specifications in the following list are now on sale.*

British Thomson-Houston Company, Limited. Electric furnaces. No. 207,823.

Hanemann, Dr. H., and Speichert, M. Furnaces operating at sub-normal pressure. No. 211,457.

Holley, E. H. Apparatus for making metal moulds. No. 222,465.

Crosthwaite Engineering & Furnace Company, Limited, and Crosthwaite, G. D. Means for feeding fuel to furnaces. No. 229,610.

227,425. Foundry Moulds.—Holley, E., 2253, Burns Avenue, Detroit, Michigan, U.S.A. (Assignee of Meloche, D. H.: 2390, Hazelwood Avenue, Detroit, Michigan, U.S.A.) December 13, 1924. No. 29,991. Convention date, January 12. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act. [Class 83 (i).]

*Mould materials.*—Permanent iron moulds and runners, for casting non-ferrous metals, are lined by numerous applications of a wash composed of lampblack 17 parts, fireclay or other refractory substance 33 parts, sodium silicate 5 parts, and water 45 or more parts. The mould should be kept at over 250 deg. F. during the process.

## Trade Talk.

THE MOND NICKEL COMPANY, LIMITED, have removed from 39, Victoria Street, S.W.1, to Victoria Station House, Victoria Street, S.W.1.

SIR ARTHUR DORMAN laid the foundation-stone of the Sydney Harbour bridge recently, Sir Hugh Bell being present.

FULLER'S UNITED ELECTRIC WORKS, LIMITED, have removed their Manchester depôt to larger premises at 19, Chapel Walks, Cross Street.

THE BRITISH ROPEWAY ENGINEERING COMPANY, LIMITED, 34, Fenchurch Street, London, E.C.3, have removed to 14-18, Holborn, E.C.1.

H. & T. DANKS (NETHERTON), LIMITED, Netherton, Dudley, notify us that their London office address is now Bank Chambers, 329, High Holborn, W.C.1.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, Wallsend, have received an order from the Ellerman Lines for an 11,400 tons cargo steamer. The engines are to be supplied by the Wallsend Slipway & Engineering Company, Limited.

DELCO-REMY & HYATT, LIMITED, makers of roller and ball bearings, 56, Victoria Street, London, S.W.1, have revised their selling prices. In the great majority of cases prices are substantially reduced. The range of Hyatt solid race bearings has been extended, and an entirely new range of the roller assembly series, which is now in extensive use in the clutch spigot, constant mesh spigot, layshaft and fan positions.

FOLLOWING A CONFERENCE at Euston, an acceleration of the locomotive building programme of the L.M.S. Railway has been brought about which will result in a yield of 319 new engines for service on the system this year, representing delivery at the rate of one a working day. In addition, work will be begun during the year upon a further 91 locomotives, which will be ready for delivery early next year.

CONTRACTS FOR THE construction of four motor-driven oil tankers of 10,000 tons each have been placed with two Tynside firms by the Anglo-Saxon Petroleum Company, Limited. Orders for two other vessels of similar type and tonnage have been placed on the Continent. It is believed that two of the vessels will be built by Palmers Shipbuilding & Iron Company, Jarrow, and two by R. & W. Hawthorn, Leslie & Company, Hebburn.

MR. W. F. WHITWELL, of W. Whitwell & Company, Limited, of Thornaby, has announced that it is the firm's intention to blow out the two remaining blast-furnaces at present in operation at the Thornaby works. The battery of 75 coke-ovens will also be allowed to cool, and the whole works will cease operations. The remaining furnace in blast at the Seaton Carew Ironworks is now being blown out. A few weeks ago the coke-ovens at these works closed down, as well as one of the furnaces.

## Personal.

BRIG.-GENERAL C. H. WHITTINGTON has resigned his position as a special director of Mather & Platt, Limited.

MR. A. F. GIBBARD, of Birmingham, has been appointed secretary of the National Society of Brass and Metal Mechanics.

MR. A. W. TAIT has resigned his directorship of the British Aluminium Company, Limited, and has been succeeded in the chairmanship by Lieut.-Col. S. H. Pollen.

MR. H. E. PARKES, of E. Parkes & Company, Limited, and Wm. Roberts (Tipton), Limited, has been elected president of the Birmingham Chamber of Commerce. He is a son of the late Sir Ebenezer Parkes.

MR. A. J. CAMPBELL, the new president of the Institution of Engineers and Shipbuilders in Scotland, is general manager of William Beardmore & Company, Limited, Dalmuir. For four vacancies among the vice-presidents, the following have been nominated, and will be elected:—Mr. J. Brown, Scott's Shipbuilding & Engineering Company, Greenock; Prof. P. A. Hillhouse, Glasgow University; Mr. R. B. Mitchell, electrical engineer to Glasgow Corporation; and the Right Hon. Lord Weir of Eastwood.

### Wills.

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| WORDINGHAM, C. H., of Redhill, a well-known consulting engineer ..... | £11,976 |
| WILLIAMS, E., chairman of H. W. Ward & Company, Limited, machine tool makers, Birmingham ..... | £98,539 |
| BREMNER, D., retired shipbuilder, formerly of Dunlop, Bremner & Company, Limited, of Port Glasgow, a director of the Steel Company of Scotland, Limited | £143,859 |
| WOOD, J., of Albany House, Wisewood, Sheffield, founder of J. Wood & Sons (Wisewood), Limited, Wisewood Forge and Rolling Mills, Sheffield ..... | £1,098 |

## Obituary.

MR. C. A. GRUMAN, consulting roller at the Templeborough Works of Steel, Peech & Tozer, Limited, a position which he had held for the last five years, has died at the age of 46 years.

MR. G. JONES died recently at Comptoir, near Wolverhampton, in his 90th year. He was a former general manager of Bayliss, Jones & Bayliss, Limited, Wolverhampton. Mr. Jones retired in 1902 after 40 years' service with the firm.

MR. T. LEWIS, who has died at Bryngwyn Hall, Gorseinon, at the age of 72, was one of three brothers who were industrial pioneers in the district. He, with his surviving brothers, Colonel D. Lewis, J.P., and Mr. R. Lewis, established a steel and tinplate works at Gorseinon, which developed into one of the most important tinplate undertakings in Wales. Two years ago they were incorporated in the Folland group of steel and tinplate works.

MR. S. P. AUSTIN died on March 25 at his residence, Hollin Hall, near Ripon. Mr. Austin, who had been ill about three weeks, was 82 years of age. A native of Sunderland, Mr. Austin was a member of a very old shipbuilding family. His grandfather, who died in his 93rd year, founded, in 1829, the firm with which Mr. S. P. Austin was connected, and which has since it was made a limited liability company been known under the style of S. P. Austin & Son, Limited. Mr. S. P. Austin was for many years the head of this concern, and under his direction it has had a most successful career, the work being chiefly in the building of vessels of the collier type, and in repairing vessels.

MR. J. H. BARNBROOK, the steel works manager of Braby's Eclipse Steel Sheet Rolling Mills, Glasgow, died suddenly at his residence, Highbury, Bearsden, on Friday, March 27. He appeared to be in his usual health up till a few weeks ago, when he complained of heart strain, but it was thought that a short period of rest would be sufficient, and it came as a great shock to his numerous friends when it was learned that he had died suddenly from a heart seizure. Mr. Barnbrook was 57 years of age, and had been at the Eclipse Works, Glasgow, since the commencement of the No. 1 Rolling Mills Plant sixteen and a-half years ago. He received his early training in the steel sheet rolling business at Messrs. Parke's works, West Bromwich, after which he spent some years as mill manager at Messrs. Lysaght's works, Newport, Mon., and afterwards at Messrs. Shaw's works, Huyton Quarry. He was well liked both inside and outside the works, and this was demonstrated by the very large and representative attendance at his funeral, which was attended by hundreds of the mill workers.

## Company News.

**Vickers, Limited.**—No dividend on ordinary shares for the year 1924.

**Stanton Ironworks Company, Limited.**—Dividend on 6 per cent. cumulative preference for half-year.

**Nantyglo and Blaina Ironworks Company, Limited.**—Dividend £2 per share, less tax, on account of arrears on 8 per cent. preference.

**Birmingham Small Arms Company, Limited.**—Profit, £305,320; ordinary share dividend, 5 per cent., less tax; carry forward, £177,147.

**Auster, Limited.**—Profit, £7,790; brought forward, £15,628; available, £23,418; dividend, 10 per cent. on ordinary shares for year, less tax; carry forward, £18,690.

**British Electric Transformer Company, Limited.**—Net profit, £35,174; reserve, £10,000; depreciation, £5,000; 7 per cent. cumulative preference dividend for six months to June 30, 1923; carried forward, £9,674.

**Scottish Tube Company, Limited.**—Net profit, £53,593; brought forward, £13,249; interest on debenture stock, £2,360; reserve, £5,000; dividend, 4 per cent. on ordinary for year, less tax; carried forward, £16,539.

**Ransomes and Rapier, Limited.**—Credit balance, £26,587; net profit, £22,180; brought forward, £20,870; disposable balance, £43,050; ordinary dividend, 12 per cent., free of tax; reserve fund (making £71,024), £5,000; carry forward, £22,449.

**Metropolitan-Vickers Electrical Company, Limited.**—Profit, £178,807; brought forward, £85,517; available, £264,325; general reserve account, £25,000; dividends on ordinary and preference to December 31 last, 8 per cent. per annum, less tax; carry forward, £92,385.

**A. Reyrolle & Company, Limited.**—Profit, £66,200; brought forward, £17,008; available, £82,709; dividend, 7 per cent. per annum on preference shares, £2,800; dividend, 12½ per cent. per annum on ordinary, £35,203; reserve account, £25,000; carried forward, £19,705.

# IRON AND STEEL MARKETS.

## Pig-iron.

**MIDDLESBROUGH.**—In view of the impending holidays, any increase of activity in the Cleveland iron trade was hardly to be expected, and the week's business accordingly has been quiet and without incidents of interest or importance. There has been, however, a fair amount of inquiry in the market, but buyers have evidently not been prepared to follow even the slight stiffening of values recorded recently, with the result that the volume of business has fallen right away again. Prices continue at weak levels, with No. 3 G.M.B. quoted at 77s. 6d., No. 1 82s. 6d., No. 4 foundry 76s. 6d., and No. 4 forge 75s. 6d. per ton.

The Tees-side market for hematite is again dull and depressed, with the result that local furnaces are going out of blast, and stocks are steadily accumulating in makers' yards. Prices are consequently further weakened, with East Coast mixed numbers offering at 83s. per ton, with concessions on that figure obtainable for fair-sized orders. Business on the West Coast is no better, with quotations ruling for Bessemer mixed numbers at 90s. c.i.f. Welsh ports, 95s. per ton delivered at Glasgow, 100s. per ton delivered at Sheffield, and 102s. 6d. delivered at Birmingham.

**LANCASHIRE.**—Buying of foundry pig in this district is on a restricted scale, Northamptonshire makers now offering freely at 72s. 6d. on trucks for their No. 3 quality, while Derbyshire makers are endeavouring to keep their price at 77s. 6d., or 5s. more than the above figure, and, of course, so far as the Manchester consumer is concerned, they can do this, because they have an advantage of nearly 5s. in the railway rate.

**THE MIDLANDS.**—Markets for foundry iron in this district continue quiet, with forward buying practically suspended for the time being, prices ruling as follow: Derbyshire No. 3 foundry, 77s. 6d.; forge, 73s.; Staffordshire No. 3 foundry, 78s. to 80s.; forge, 74s. 6d.; Northants No. 3 foundry, 71s. to 72s. 6d.; forge, 68s. to 70s.

**SCOTLAND.**—The position as concerns this particular area has undergone little change of late, with buying in the foundry iron markets in very limited volume. Quotations for No. 3 foundry quality rule easy at 88s. per ton, with few buyers at that figure.

## Steel.

Conditions in the markets for steel and its various products evidence little change for the better, billets being in quiet demand, even imported semis being neglected. The Australian naval order recently placed with a Sheffield firm will, it is held, help business, but some time must elapse before this can be felt appreciably. Open-hearth steel production is being cut down, and only a small proportion of the furnaces are now operating, and these chiefly on acid steel. Steel exports have shrunk heavily. Heavy forging and casting work is falling off, but the light steel trades are rather busier again. Wire rod production is now smaller than at any time this year. Quite a fair amount of business was reported in the tinplate market last week, current quotations for the standard sizes ruling as follow:—Coke Tins.—IC, 14 x 20, 112 sheets, 108 lbs., 22s. 1½d. to 22s. 3d. per box; IC, 28 x 20, 56 sheets, 108 lbs., 22s. 7½d. to 22s. 9d. per box, all net cash, f.o.b. Bristol Channel ports.

## Scrap.

Reports from the various markets for scrap metal indicate little improvement, with a very quiet business doing all round. For textile machinery scrap in Lancashire founders are indifferent buyers at 80s. for ordinary and 85s. for special qualities. There is not much work in hand at the foundries, so that the quantity of cast scrap needed for mixing purposes is limited. It is said that ordinary cast scrap has been done at 75s. per ton, but this must have been in the hands of a very weak holder. In Scotland, machinery cast-iron scrap is also quiet with very little business doing. Some small parcels have been disposed of around 85s. to 87s. 6d., and for ordinary quality suitable for foundries 5s. per ton less.

## Metals.

**Copper.**—Following the recent slump in standard values, sentiment in the market has assumed a more cheerful aspect, and a sustained buying movement of both near and three months copper, with sellers more reserved, caused a steady improvement in values, the close being decidedly firmer than was the case earlier on. Henry Gardner & Company are of opinion that the cumulative effect of selling pressure in the New York market had considerable effect recently, and values there dwindled rather rapidly. Current quotations:—*Cash*: Thursday, £60 5s.; Friday, £60 5s.; Monday, £60 2s. 6d.; Tuesday, £60 7s. 6d.

*Three Months*: Thursday, £61 7s. 6d.; Friday, £61 7s. 6d.; Monday, £61 5s.; Tuesday, £61 10s.

**Tin.**—Although the decline in tin values in evidence of late has been checked to some extent, recovery is somewhat slow, and business on the whole is quiet.

Stocks of tin, landing and afloat, in Europe and America, according to Ricard and Freiwald's statement, amounted to 18,000 tons on March 31, 1925, against 21,951 tons at the end of February, showing a decrease in the total visible supply of 3,951 tons. Monthly supplies from all sources amounted to 6,980 tons, against 11,055 tons for the previous month, deliveries in that period being 10,931 tons, against 10,459 tons for February. Current quotations:—*Cash*: Thursday, £237 5s.; Friday, £233 15s.; Monday, £231 5s.: Tuesday, £232.

*Three Months*: Thursday, £241 5s.; Friday, £237 10s.; Monday, £234 15s.; Tuesday, £235 5s.

**Spelter.**—Demand for this metal also evidences signs of slackening, and prices are distinctly weaker. H. Gardner & Company write that the market is still suffering from a shortage of spot metal, and apart from this factor no new feature has arisen. Galvanisers are not active. Current quotations:—*Ordinary*: Thursday, £34 3s. 9d.; Friday, £34 6s. 3d.; Monday, £34 7s. 6d.; Tuesday, £34 11s. 3d.

**Lead.**—The seasonable revival in consumption of this metal, which had quite reasonably been expected, has not as yet come about, and hence the market presents a rather dull appearance. Stocks are not accumulating, but, on the other hand, America has evidently metal to dispose of, and has been selling regularly from day to day. Current quotations:—*Soft foreign (prompt)*: Thursday, £35; Friday, £34 7s. 6d.; Monday, £33 10s.; Tuesday, £32 17s. 6d.

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Mr. O. Grazebrook, of Himley House, the new High Sheriff of Worcestershire, is managing director of M. & W. Grazebrook, Limited, of Netherton, an iron works that has been in existence since 1750; he is also a director of the Birmingham Canal Navigation and of several private companies.

The Chilean Government is in the market for a considerable amount of rolling stock to be used on the Iquitos-Pintados section of the Ferrocarril Longitudinal, which is now to be worked by the State Railways. The efforts of the Department of Public Works to dispose of this section to private interests have not proved successful.

At the annual meeting of the North-Western Branch of the Institution of Mechanical Engineers, held on March 19, Professor Gerald Stoney, the chairman of the branch, occupying the chair, Mr. Z. St. L. Pendred said the most important task which faced mechanical engineers in the future was the improvement of the general status of their profession. Civil engineers were generally respected, but the mechanical engineers had to be content with smaller things. Until they attracted larger-minded men, men of a wide outlook on life, the profession of mechanical engineering would never receive the recognition to which it was entitled.

**Parker, Winder & Achurch, Limited.**—Presiding at the annual meeting in Birmingham recently, Sir William Bowater stated there was a marked improvement in the company's financial position, the net profit (£8,000) being double that of the previous year. This enabled the directors, after paying the same dividend, to place £5,000 to reserve, besides a substantial sum to carry forward. As this was the first occasion since the boom year of 1920 that the directors had been able to add to the reserve fund, they did not recommend an increase in dividend, but he thought it would be appreciated that the finances of the company would be on a sounder basis. A very large number of new customers had been added during the year. At the moment all order books were well filled, and the expectation of business, in spite of difficult times, was most gratifying. Sir William added that he thought in their trade they could expect even better things this year than last year. There was a better feeling between employers and employed than there had been for the last three or four years.